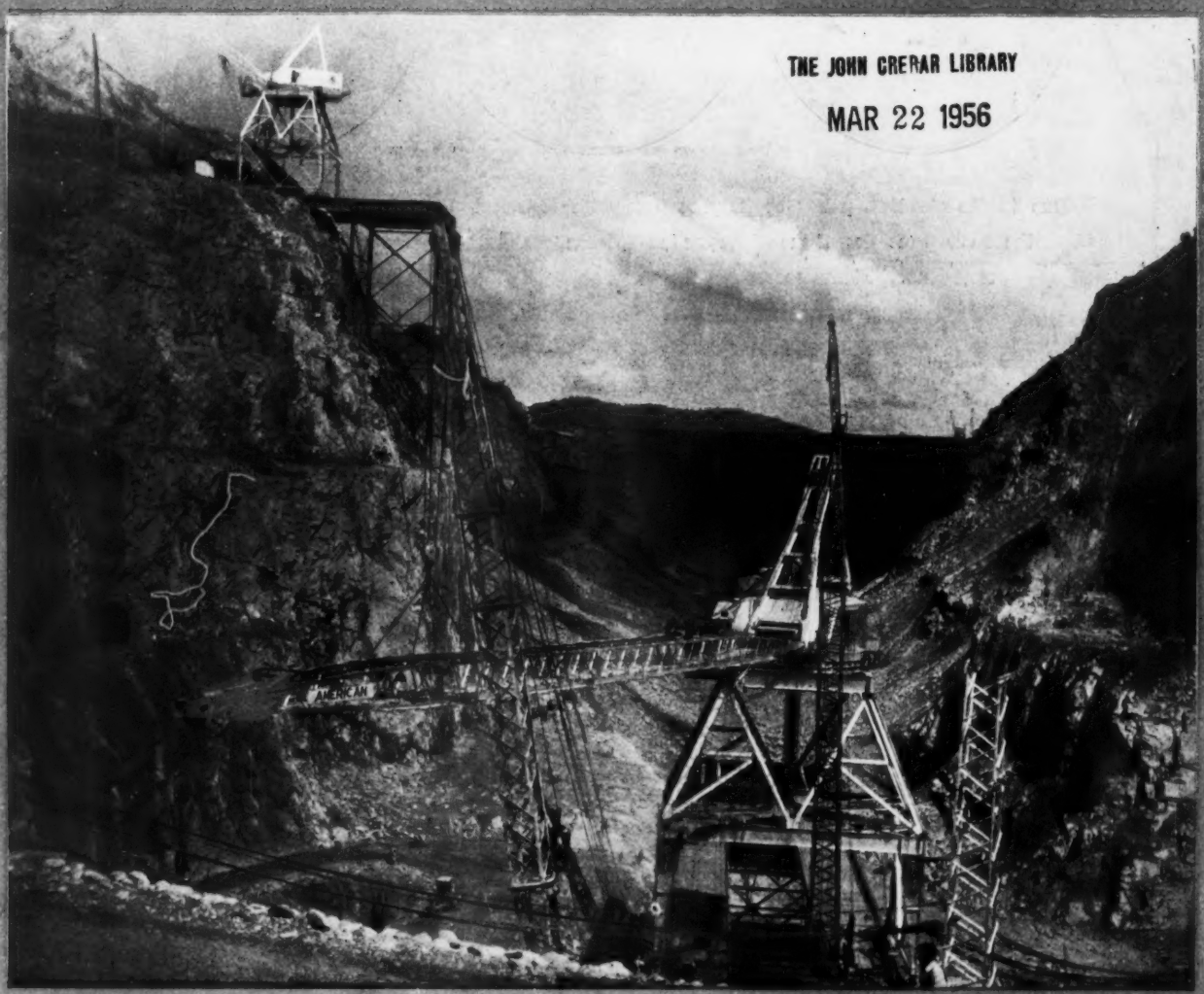
T2
163

INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

VOL. V, NO. II NOVEMBER 1955 RUPEES TWO



THE JOHN CRERAR LIBRARY
MAR 22 1956

CONCRETE PLACING CRANES BEING FITTED AT BHAKRA DAM SITE

MANNESMANN

Due to the steadfast policy of keeping pace with technical progress and constantly improving the basic principles of the Mannesmann brothers' revolutionary invention of the seamless steel tube, Mannesmann pipes today enjoy a firmly established reputation throughout the world for dependability, safety, and economy.

Whether it is a question of conveying gas, water, steam or oil, or providing service connections and plumbing systems, or whether long-distance transmission lines and penstocks—no matter how high the gradients have to be constructed; Mannesmann tubes and pipes can be relied upon to meet fully the severest requirements of any particular application.

MANNESMANN EXPORT GMBH

DÜSSELDORF

10326

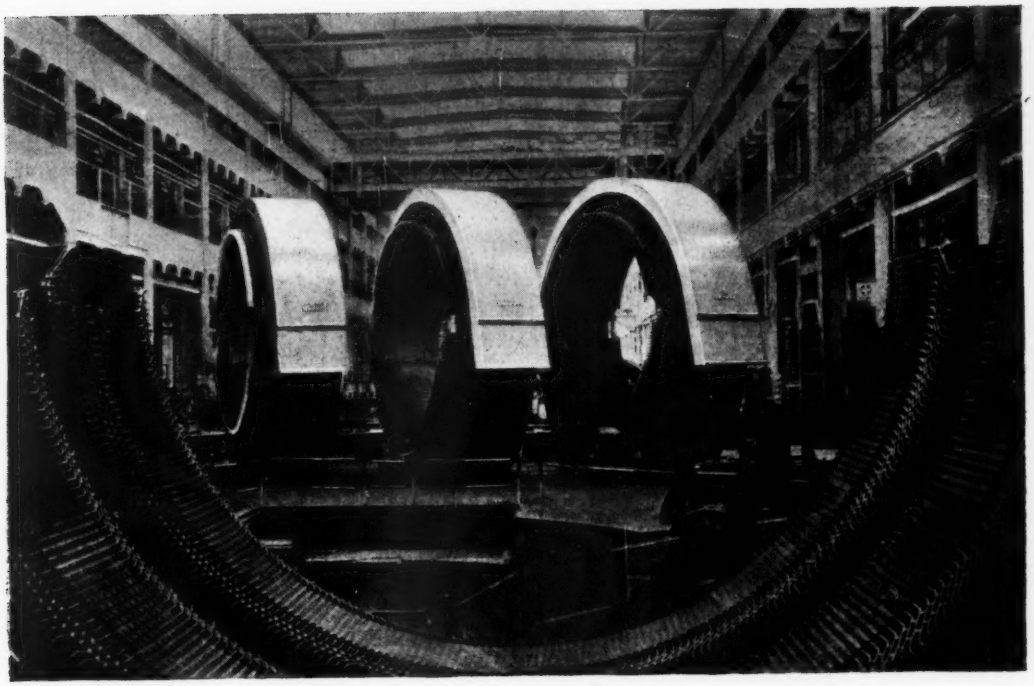
Sole Representatives in India

DODSAL LIMITED

BOMBAY—DELHI—CALCUTTA

Visit our exhibition stand at the Indian Industries Fair, New Delhi (October, 29—December 31, 1955).

SIEMENS



1/42E

Power for Everybody

Three Stators of large synchronous generators for the Maithon Hydroelectric Station, DVC. Each generator has an output of 29,000 kVA at 11 kv and 176·5 rpm.

SIEMENS - SCHUCKERTWERKE AKTIENGESELLSCHAFT
GERMANY

SOLE REPRESENTATIVES IN INDIA:
PROTOS ENGINEERING COMPANY LIMITED
SIEMENS DEPARTMENT
BOMBAY - CALCUTTA - NEWDELHI - MADRAS

longevity

Pipe mains conveying water and distributing gas, providing sanitary services and carrying oil, are the lifelines of civilisation.
Today the Cast Iron Pipe, with Spigot and Socket Joints, provides the most widely used medium for the transmission of water and gas.

Manufactured to British Standard Specifications.

THE INDIAN IRON & IISCO STEEL COMPANY LTD

THE INDIAN IRON & STEEL CO., LTD.

Managing Agents :

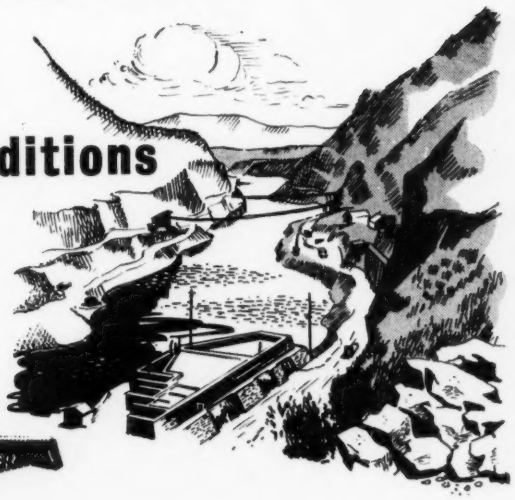
MARTIN BURN LTD. 12 Mission Row, Calcutta.

Branches : **New Delhi** **Bombay** **Kanpur**

IIX 48

The first choice for Indian conditions

Muir-Hill Regd. *DUMPERS*



3 CU. YD.
MODEL 10B

4½ CU. YD.
MODEL 14B

Muir-Hill Dumpers and Loaders have been in use in the Indian Continent for over twenty years and they have proved equal to the toughest assignments in the widest range of climatic conditions.

All users of Muir-Hill machines are assured of service and spares through our distributors. The undermentioned will be glad to send fully illustrated literature on request.

BUILT BY BOYDELL

E. BOYDELL & CO. LTD., ALLIANCE WORKS, OLD TRAFFORD, MANCHESTER 16, ENGLAND

DISTRIBUTORS IN INDIA

Messrs. Killick, Nixon & Co. Ltd., P.O.B. 109, Killick Buildings, Home Street, Bombay.

Territories:

Bombay State, Madhya Pradesh, Hyderabad, Rajasthan, Kashmir, PEPSU & Himachal Pradesh.

Messrs. McLeod & Co. Ltd, McLeod House, P.O.B. 78, Postal Zone No. 1, Calcutta. Also at P.O.B. 153. Race Course Road, Coimbatore.

Territories:

Delhi, Uttar Pradesh, Bihar, West Bengal, Assam, Orissa, Madras State, Mysore, Travancore and Cochin States.

dm EB 549

electrical equipment from Poland

exports of the highest quality at competitive prices

ELECTRICAL MOTORS, TRANSFORMERS AND FURNACES

Squirrel-cage and slip-ring asynchronous motors

Synchronous machines

Special design flame-proof electric motors

Electric lift motors, multi-speed types

Direct current electric motors and generators

Rotary and transformer arc welding sets

Oil and special transformers

Electric industrial furnaces

Induction furnaces and oil condensers

ELECTRIC APPARATUS

Low and high tension curcuit breakers

Low and high voltage lightning arresters

Single and three-phase KWh meters

Flame-proof mining apparatus

OTHER EQUIPMENT

Low and high voltage static condensers for power factor correction

Fire alarm plants

Radio transmission and reception equipment of all kinds

Porcelain and bakelite material for factory and house power installations

Contact the Elektrim representative at the Indian Industries Fair, New Delhi.

„Elektrim"

15|17, Czackiego, Warsaw, Poland. Cables : ELEKTRIM.

MUCONE POWER STATION
No. 1, ITALY

PENSTOCKS IN COURSE OF ERECTION

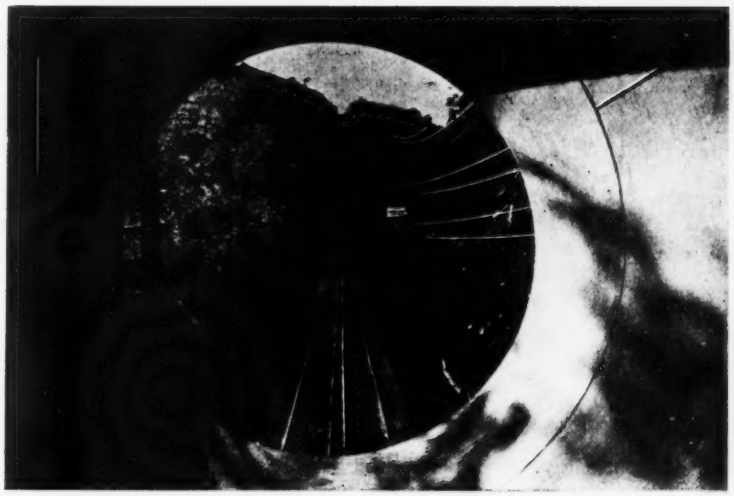
Head—752 metres
Diameter—2·50-2·20-2·00 metres

DESIGNERS AND MANUFACTURERS OF THE MOST MODERN AND POWERFUL HIGH PRESSURE PIPE-LINES WITH A WORLD WIDE REPUTATION

★

EARLY DELIVERY

★



COFOR

SOC. CONDOTTE FORZATE. MILANO — VIA DELLA POSTA 8/10 MILAN. ITALY

Telegraphic Address : CONDOFORZ, MILAN, ITALY

Associated with Terni, Soc. per l' Industria e l' Elettricita, Terni, Italy
ETAB[TS], Bouchayer and Viallet, Grenoble, France
Soc. Dauphinoise d' Etudes et de Montages, Grenoble, France

Steel Structures
Mechanical Plant
Ropeways & Cableways
Steel and Manganese Steel castings upto 4 tons weight

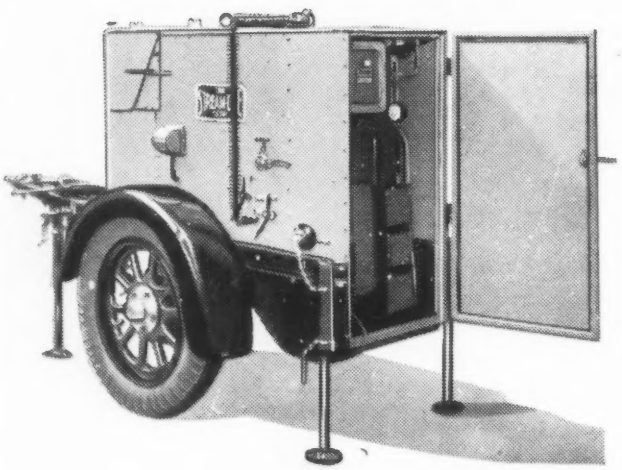
Accurate milling and hobbing of gears
Light, medium and heavy turning and boring
Heavy and medium planing

KUMARDHUBI ENGINEERING WORKS LTD.

Managing Agents :
BIRD & CO., LTD.
Chartered Bank Buildings, Calcutta-1

B 236

SERVICING TRANSFORMER OILS



The Trailer-Mounted Streamline Filter illustrated is designed to service Transformer and Switch Oils at site by removal of all suspended matter and particles of moisture, thus improving the dielectric strength of these oils upto 100% of their original value.

Capacities vary from 5 to 450 gallons per hour. They can be operated with absolute safety without closing down the plant. The cost of servicing these oils is insignificant in the light of security and economy effected by regular and efficient conditioning of the insulating oil.

Consult: **HEATLY & GRESHAM LTD.**

Sole Agents for **WEST BENGAL, BIHAR, ORISSA & ASSAM**

For **STREAM-LINE FILTERS LTD.**

LONDON—ENGLAND

If you have to beat a tight schedule, keep cost down and maintain high operating efficiency . . . you need Coles. There is a Coles Crane for every purpose. Coles Cranes feature a diesel-electric transmission system, low operating cost and utmost reliability.

Coles Cranes are available in India in a wide range of models both mobile and stationary, Standard and Custom-built and with capacities of up to 40 tons.

COLES **THE NAME THAT CARRIES WEIGHT**

TRACTOR & EQUIPMENT CORPORATION LIMITED
P. O. Box 279, NEW DELHI.

TRACTORS (INDIA) LIMITED
P. O. Box 323, CALCUTTA
P O. Box 66, LUCKNOW.

LARSEN & TOUBRO LIMITED
P. O. Box 278, BOMBAY
P. O. Box 5247, MADRAS.

WILLCOX (BUCKWELL-INDIA) LIMITED
P. O. Box 289, NEW DELHI
New Colony, JAIPUR.

CC/C/6

S&L

STEWARTS AND LLOYDS OF INDIA, LIMITED

PUBLIC SERVICES
Air, Gas, Water and Sewage Mains.

POWER
Steam Mains and Pipework Installations.

OIL COUNTRY GOODS
Casing, Line Pipe and Tubing.

TUBEWELLS
Casing, Drive pipes, Liners and Housing pipes.

MINING
Compressed Air, Fire Fighting, and Rising Mains.

SHIP'S EQUIPMENT
Derricks, Davits and Masts.

POLES
Tramway, Transmission, Lighting.

SPECIAL USES
Ammonia Tubes, Coils, Hydraulic Tubes.

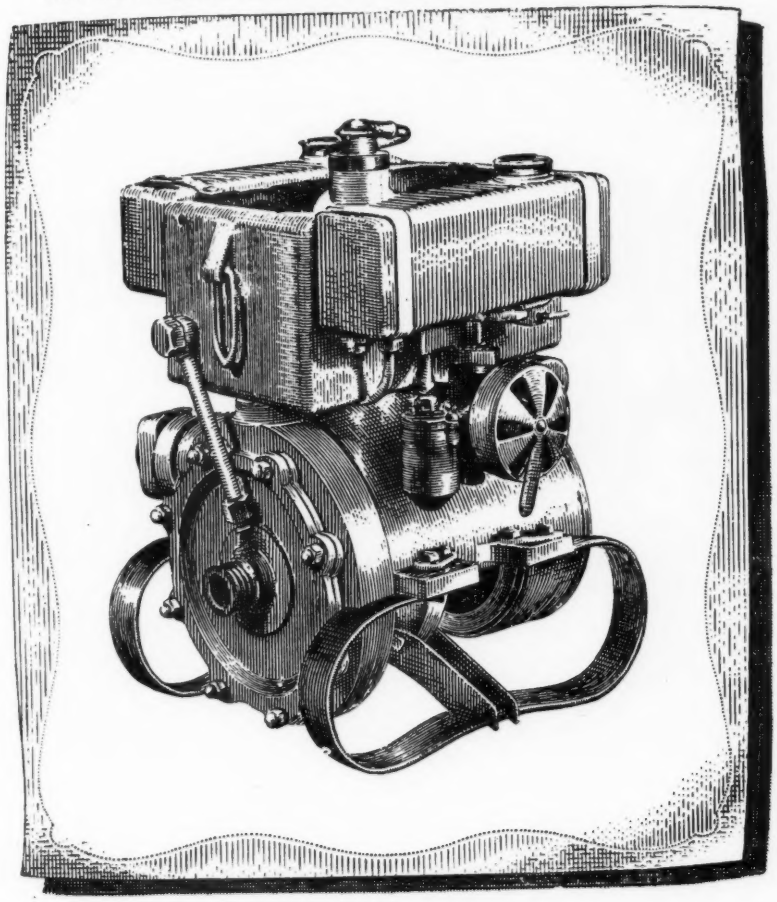
STRUCTURAL
Light Structures of Tubular Construction.

MECHANICAL HANDLING
Pallets, Stillages and Trolleys of Tubular Construction.

HEAD OFFICE:
41, CHOWRINGHEE ROAD, P.O. BOX 270, CALCUTTA
TELEPHONE: CIRCUS 5224-5228 (5 LINES)

WORKS:
39, HIDE ROAD, KIDDERPORE, CALCUTTA
TELEPHONE: ALIPORE 4561

Visit the Hungarian Pavilion at the Indian Industries Fair, New Delhi.



PUMPS

Cold and hot water Pumps
Mine Pumps
Fire fighting Pumps
Acid-proof Pumps
Irrigation Pumps
Deep-well Pumps
Vacuum Pumps

In various capacities
For favourable delivery times

»TECHNOIMPEX«

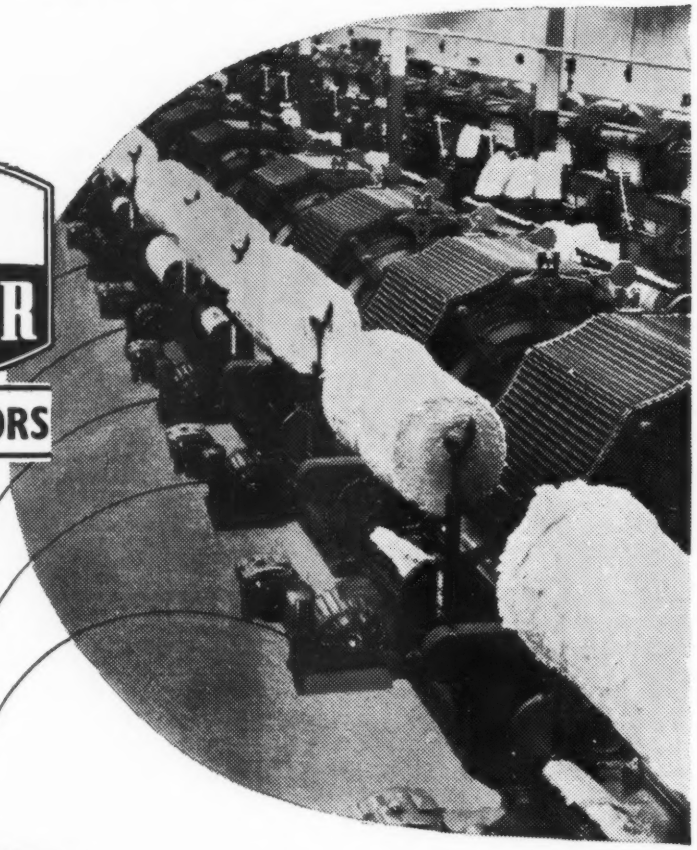
HUNGARIAN MACHINE INDUSTRIES FOREIGN TRADE CO.

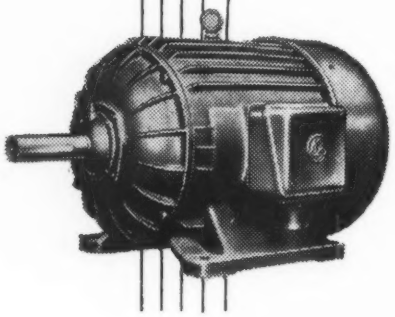
BUDAPEST 62 P.O.B. 183 HUNGARY

Represented by : B. K. KHANNA & CO. LTD.
14 F, Connaught Place, New Delhi.

Another Typical Installation

BRUSH
KIRLOSKAR
ELECTRIC MOTORS





82 of these motors are used in driving carding machines in the Swatantra Bharat Mills, New Delhi.

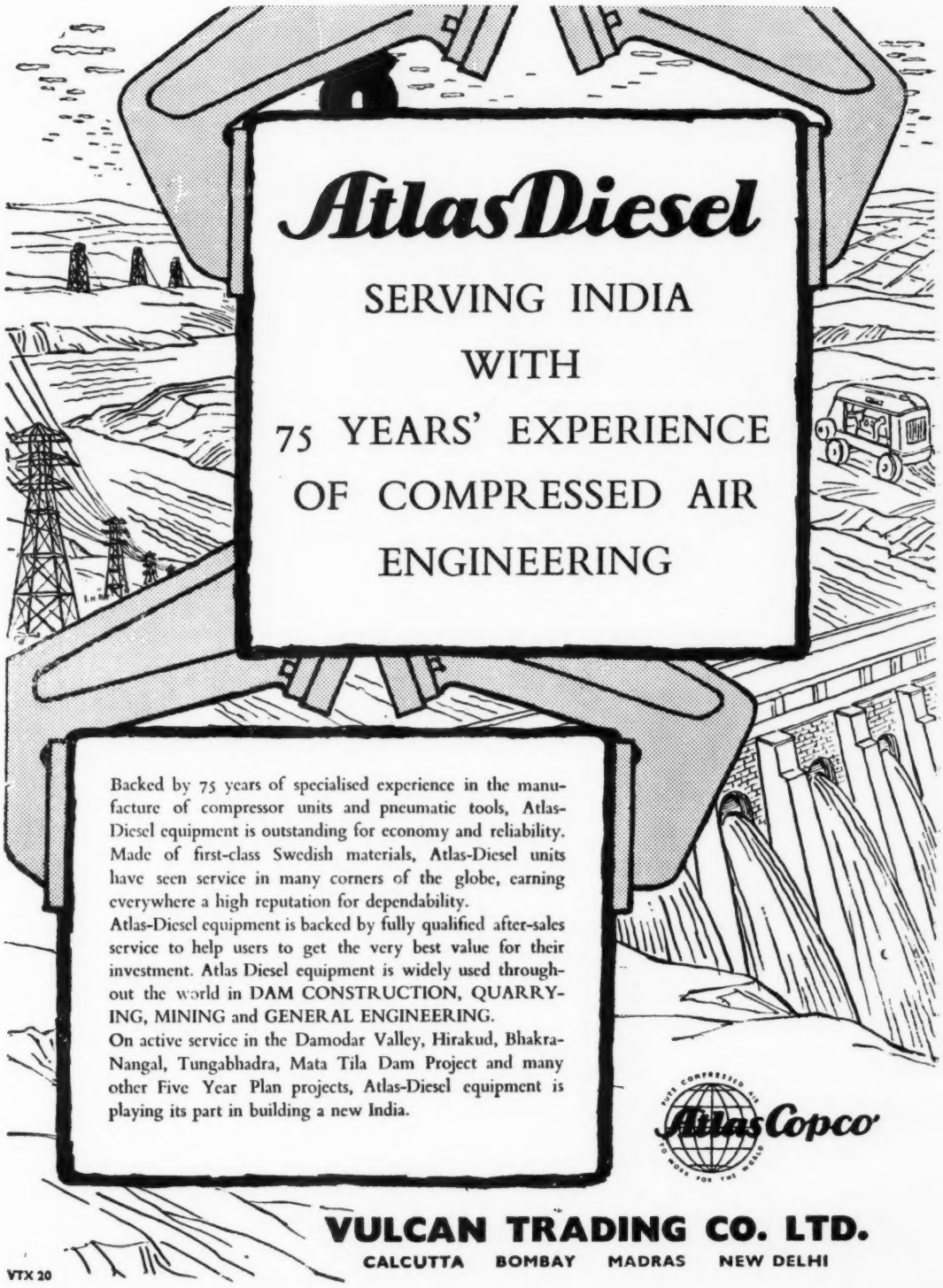
We build motors specially for the Textile industry with High Starting Torque, low temperature rise, exceptionally short overall dimensions, to meet every application in the mills.

KIRLOSKAR ELECTRIC

KIRLOSKAR ELECTRIC COMPANY LIMITED. BANGALORE-3.

SOLE AGENTS PARRY & CO. LIMITED
MADRAS P. O. Box No. 12
BOMBAY P. O. Box No. 506
CALCUTTA P.O. Box No. 208
NEW DELHI P.O. Box No. 172

GRANT


Atlas Diesel
SERVING INDIA
WITH
75 YEARS' EXPERIENCE
OF COMPRESSED AIR
ENGINEERING
Backed by 75 years of specialised experience in the manufacture of compressor units and pneumatic tools, Atlas-Diesel equipment is outstanding for economy and reliability. Made of first-class Swedish materials, Atlas-Diesel units have seen service in many corners of the globe, earning everywhere a high reputation for dependability.
Atlas-Diesel equipment is backed by fully qualified after-sales service to help users to get the very best value for their investment. Atlas Diesel equipment is widely used throughout the world in DAM CONSTRUCTION, QUARRYING, MINING and GENERAL ENGINEERING.
On active service in the Damodar Valley, Hirakud, Bhakra-Nangal, Tungabhadra, Mata Tila Dam Project and many other Five Year Plan projects, Atlas-Diesel equipment is playing its part in building a new India.
Atlas Copco
VULCAN TRADING CO. LTD.
CALCUTTA BOMBAY MADRAS NEW DELHI
VTX 20

ANSALDO S.A.

GENOVA (ITALY)

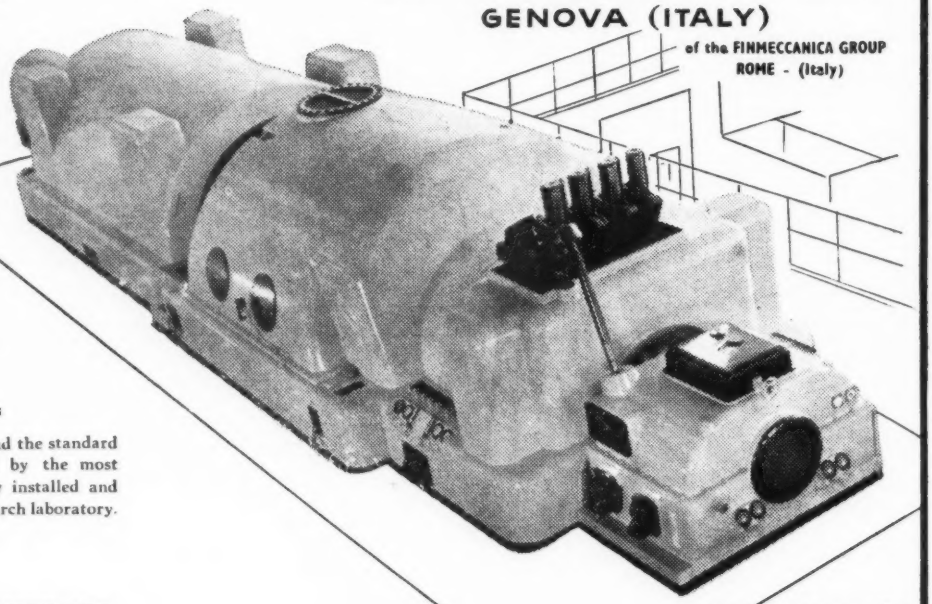
of the FINMECCANICA GROUP
ROME - (Italy)

ANSALDO S.A. are a 102 years old engineering company.

Their range of production in the power engineering field is very wide :

- Boilers for stationary and marine installations of all types and up to the highest temperatures and pressures.
- Steam turbines for stationary and marine installations.
- Diesel engines for stationary and marine installations.
- Complete steam and diesel electric power plants.
- Complete ship propelling plants

The quality of materials used and the standard of production are guaranteed by the most up to date workshop machinery installed and a most modern control and research laboratory.



60.000 KW turbogenerating set for the S.I.P. Power Station at Chivasso

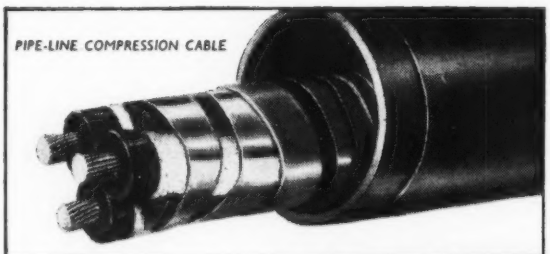
Sole Agent for India

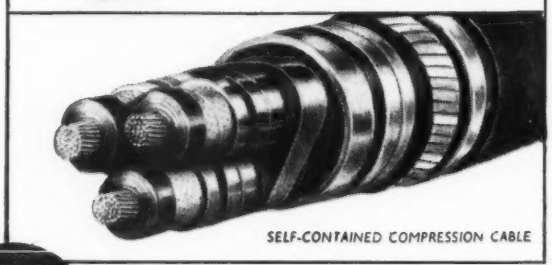
KAMANI ENGINEERING CORPN. LTD.

Bombay, Calcutta, Delhi & Madras.

F M/G/5

increased power with compression cables





To carry power loads of voltages above 66KV and up to 264KV, efficiently and economically, Enfields have evolved Compression Cables. They consist of normal paper-insulated, lead-sheathed cables of non-circular section surrounded by a gas pressure of about 200 pounds per square inch. Compression Cables are available in two different forms: the pipe-line type and the self-contained type.

AN Enfield PRODUCT

Paper Insulated Cables.
Rubber Insulated Cables.
Non-Bleeding Cables.
Signalling & Telephone Cables.
Machine & Transformer Winding Wires.
Joint Boxes & Feeder Pillars.
Grid Suspension Wiring System.

Agents in India

PHILIPS ELECTRICAL CO. (INDIA) LTD.

7, Justice Chandra Madhab Road, Calcutta 20. Branches: Bombay-Delhi-Madras-Patna-Kanpur-Lucknow-Bangalore

FLX-38

WATER...

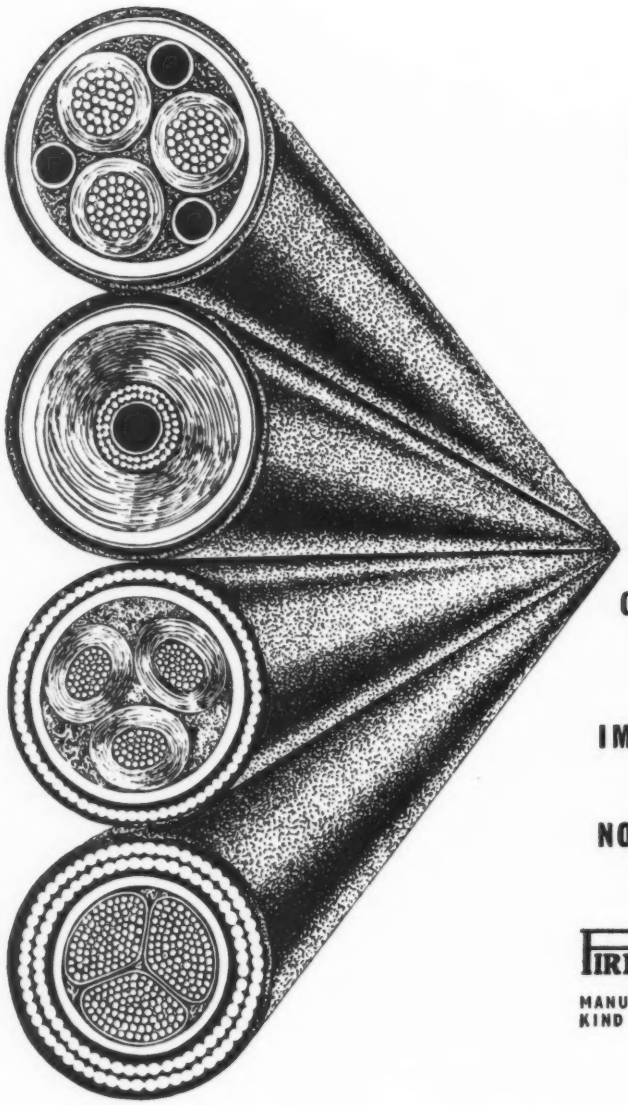
...Key to INDIA'S Future

Huwood Conveyors are playing their part in the construction of the many dams now being built across the Indian rivers — dams which have the purpose of combining irrigation with the production of cheap electric power. Dam construction is testing work for the conveyors employed .. contractors must be sure of obtaining equipment which is both reliable and exactly adapted to their needs.

Hugh Wood & Co.,Ltd..

Head Office and Factories:
GATESHEAD - ON - TYNE, 11.
Telegrams: Huwood, Gateshead. Telephone: Low Fell 76083 (5 lines).

Industrial and Export Office:
DASHWOOD HOUSE, 69 OLD BROAD STREET, LONDON, E.C.2.
Telegrams: Huwood Ave, London. Telephone: London Wall 6631-2-3.



SUPPLY
LINES
FOR
POWER

P-G

OIL-FILLED
CABLES

MASS
IMPREGNATED
CABLES

NON-BLEEDING
CABLES

PIRELLI-GENERAL

MANUFACTURERS OF EVERY
KIND OF ELECTRIC CABLE

THE GENERAL ELECTRIC COMPANY OF INDIA LIMITED
Representing: THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND

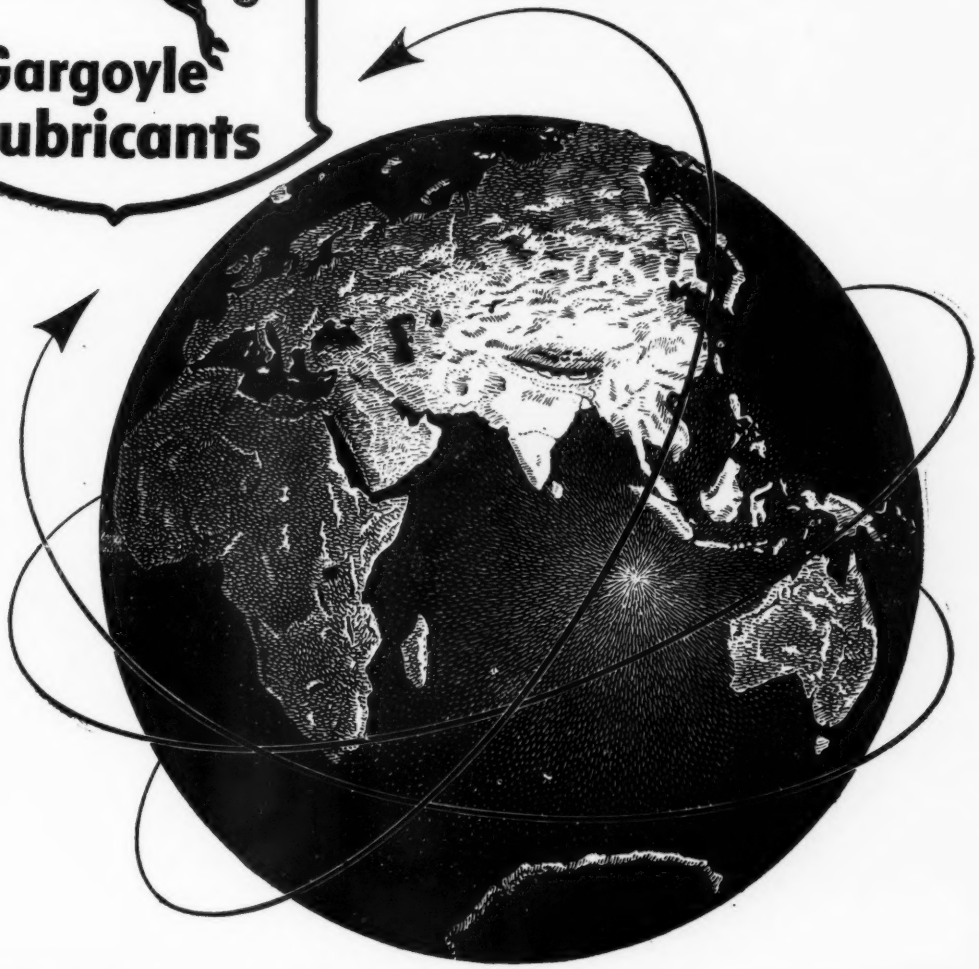
GEC 143

The Symbol of Quality Around the World!

WHEREVER machines run, the name *Gargoyle* stands for outstanding products and service in the lubrication field.

Over the past 89 years, the makers of Gargoyle Industrial Lubricants have developed the *correct* lubricant for every industrial need. Let us show you how this valuable experience can help to reduce costs and improve operations in *your* plant. Get in touch with Standard-Vacuum Oil Company . . . Bombay, Ahmedabad, New Delhi, Lucknow, Calcutta, Madras, Secunderabad.

Gargoyle Lubricants



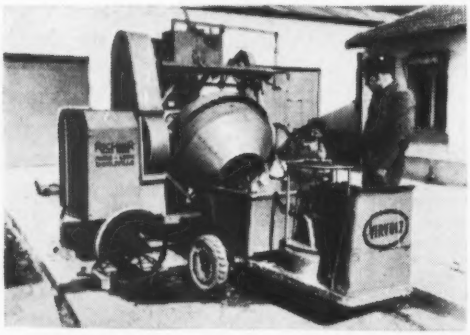
STANDARD-VACUUM OIL COMPANY (The Liability of the Members of the Company is Limited)

V. 1799

RICHIER
CONCRETE MIXERS

ARE AVAILABLE

TO MEET ALL CONCRETING PROBLEMS



With over 25 years experience in the manufacture of construction equipment, RICHIER offer an incomparable range of PORTABLE TILTING DRUM CONCRETE MIXERS with or without Power loaders.

Standard Sizes Available:

7/5, 10/7, 14/10, 16/12, 21/14, 28/21, 40/28 C. Ft.

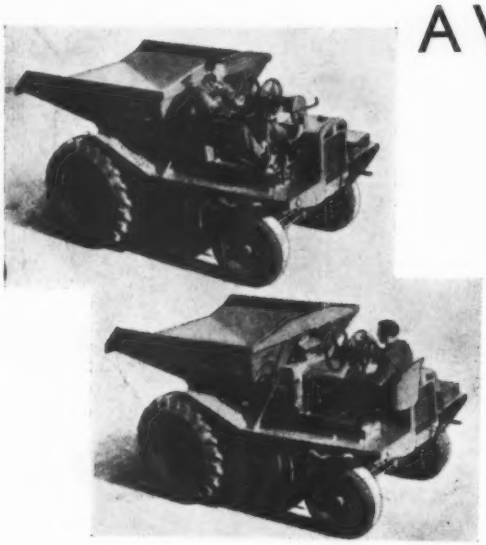
SOME MODELS EX-STOCK

RICHIER also offer NON-TILTING DRUM CONCRETE MIXERS. Sizes available 1 to 2½ cu. yds.

Write For Detailed Literature

B. R. HERMAN & MOHATTA (INDIA) LTD

19, BRITISH INDIAN STREET, CALCUTTA



AVELING-BARFORD

DIESEL ENGINE

SHUTTLE DUMPER

CAPACITIES : 3, 4½ and 7½ Cubic Yards

The 'SHUTTLE' principle adopted in the design of these machines enables them to be driven with equal facility in either direction thereby saving time in manoeuvring at the excavator and tip.

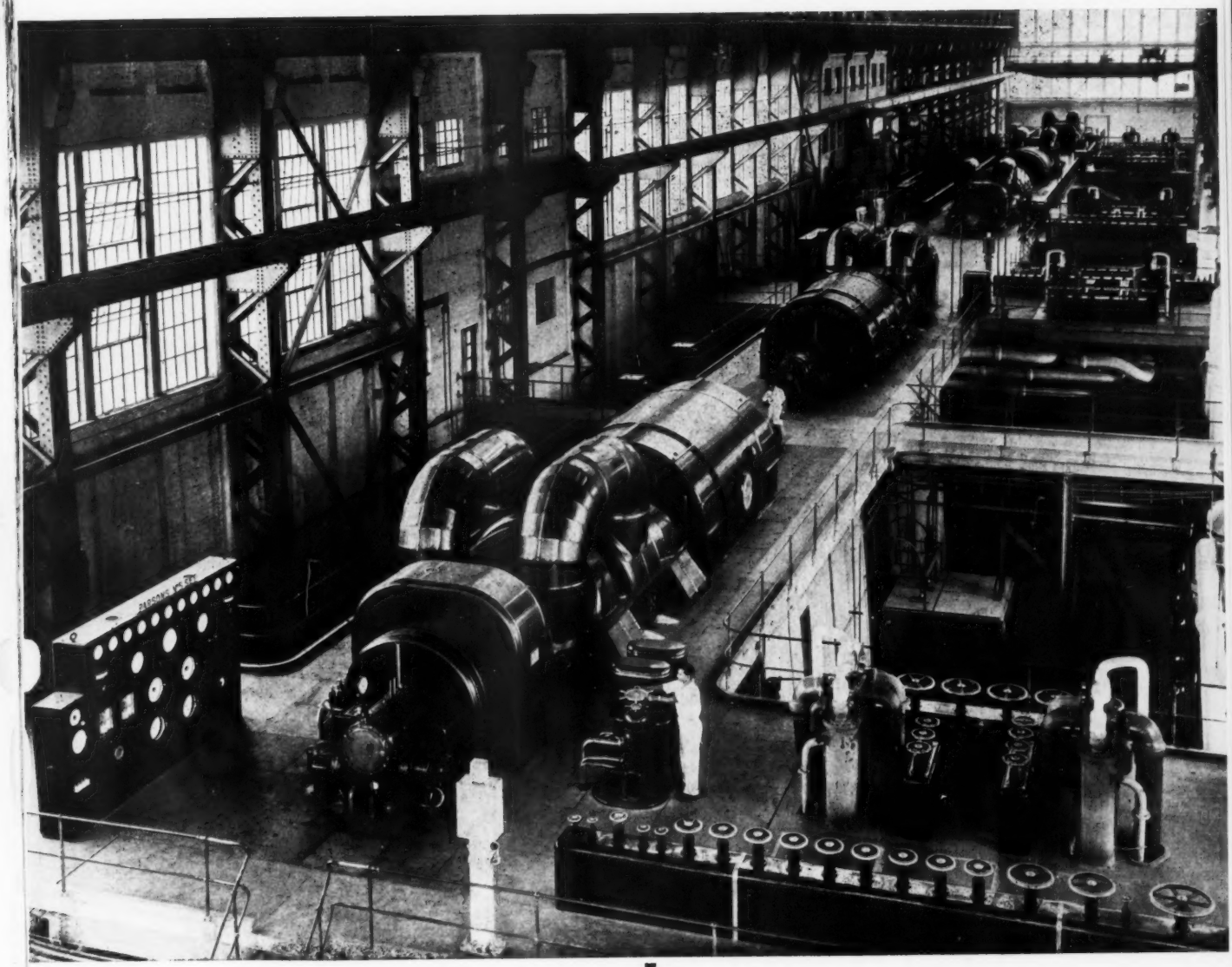
Please write for full details to the Agents:

Northern & Eastern India.
JESSOP & CO. Ltd.,
P.O. BOX 108,
CALCUTTA

Southern & Western India.
GREAVES COTTON & CO. Ltd.,
1, FORBES STREET
BOMBAY-1

The 4½ cubic yard Dumper (illustrated above) is powered by a 54 B. H. P. Dorman Diesel Engine and is fitted with power assisted tipping.

C.A.PARSONS



FIVE PARSONS 30 MW. TURBO. ALTERNATORS, GENERATING AT 33 KV. INSTALLED AT MULAJORE GENERATING STATION OF CALCUTTA ELECTRIC SUPPLY CORPORATION LTD., ARE SHOWN ABOVE

AGENTS

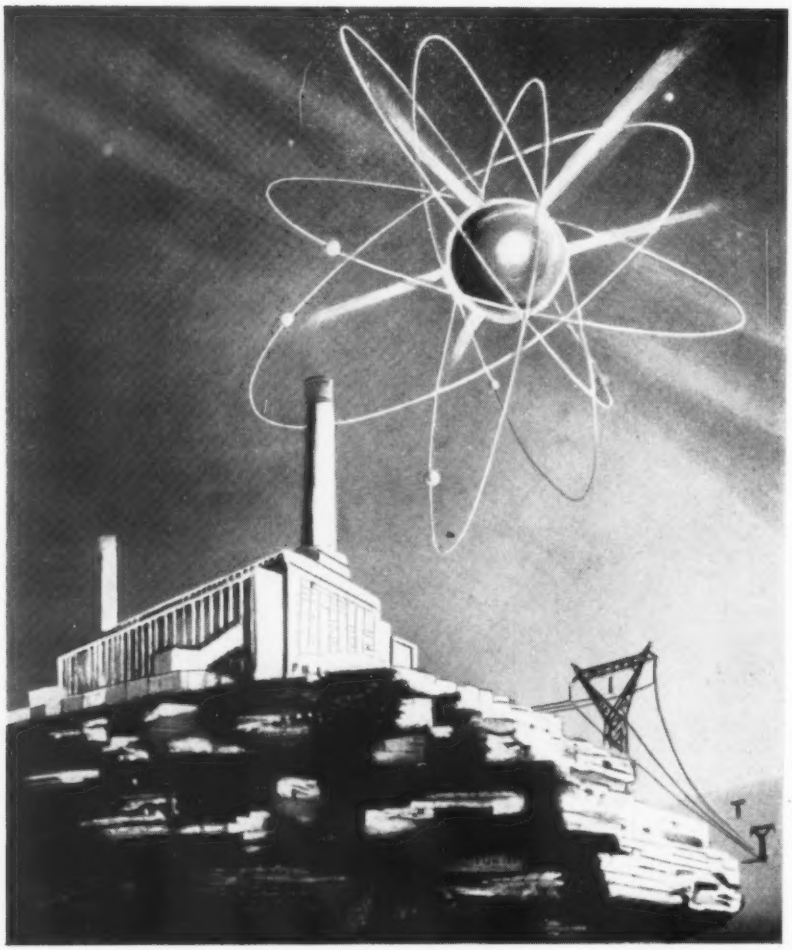
MARTIN BURN LTD.

12, MISSION ROW,

CALCUTTA.

ALSO

BOMBAY DELHI KANPUR



Over half of India's electricity is steam generated and based on coal. In the future it will derive increasingly from atomic energy, but still through the medium of *Steam*, generated in new and specialised forms of steam-raising plant. In this significant development, Babcock & Wilcox, who have supplied over 75 percent of the boilers of Indian power stations, are playing an outstanding part. Already they are constructing the steam-raising plant of Britain's first atomic electric power station.

BABCOCK

STEAM-RAISING PLANT

BABCOCK & WILCOX OF INDIA LTD.

4, Bankshall Street, Calcutta ● **16, Queen's Road Estate, Bombay 1.**

INDIAN JOURNAL OF POWER AND RIVER VALLEY DEVELOPMENT

A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : K. K. Sinha

P. K. Menon : Mg. Editor

Vol. V **November, 1955** **No. 11**

CONTENTS

CONCRETING AT BHAKRA DAM	*Vishnu Dutt*	1
THE ENGINEER'S CONTRIBUTION TO THE CONSERVATION OF NATURAL RESOURCES—II	*Sir Harold Hartley*	5
GAS TURBINE POWER PLANTS IN OPERATION	*Leo Walter*	11
SOVIET HYDRO-TURBINE ENGINEERING	*N. N. Kovalev*	15
OUR DELHI LETTER		17
NOTES & NEWS		19
ELECTRIFICATION AND SMALL-SCALE INDUSTRIES	*Editorial*	21
BOOK REVIEW		23

In the coming issue :

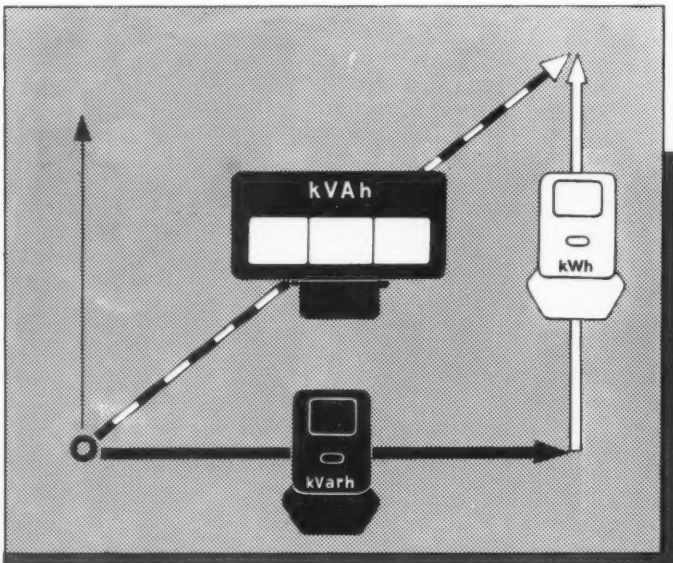
The Future of Atomic Energy *by* Sir John Cockroft, Director, Atomic Research Institute Gr. Britain; Growing Importance of Engineers *by* Sir V. T. Krishnamachari, Dy. Chairman, Planning Commission, Govt. of India; Mata Tila Dam *by* B. P. Sharma, Executive Engineer; Economic Effects of Irrigation *by* C. S. Parthasarathy, Asst. Chief, Natural Resources Division, Planning Commission; Economic Development and Political Boundaries—Editorial.

Delhi Office
18, Kakanagar
Cornwallis Road
New Delhi

Editorial and Managerial Offices
6/2, Madan Street, Calcutta-13
Phone: 23-1765 ; Gram : Tekjourn
Manager : **B. Bhattacharya**

London Representatives
Walter Judd Ltd.
47, Gresham Street
London E. C. 2

Annual Subscription : Rs. 20, £2 or $6.00. *Single copy :* Rs. 2.



LG

LANDIS & GYR

FOR ALL METERING PROBLEMS

A well equipped Testing Station and a factory specialist are available in our Bombay Establishment for repair and calibration of all Landis & Gyr meters and special apparatus.

VOLTAS

VOLTAS LIMITED Head Office: Bombay 1
Calcutta • Madras • New Delhi • Cochin • Ahmedabad
Secunderabad • Lucknow.

Concreting at Bhakra Dam

VISHNU DUTT

In our special Number on Bhakra-Nangal Project published two years back, we published an article entitled "Planning the Bhakra Dam" by Sri S. D. Khungar, General Manager of the Project, in which he explained the various phases of and the complexities involved in the planning of the execution of this admittedly stupendons project—the Bhakra Dam. Now the years of patient and meticulous hard work has come to fruition. On November 17, Sri Jawahar Lal Nehru threw the first bucket of concrete into the foundations. In this article the various aspects in the concreting of the Dam is briefly indicated. The magnitude of the task can be imagined from the very fact that from Nov. 17, 1955 onwards till 1959 the concreting work will go on uninterruptedly with machines which are the biggest yet used in this country as well as outside.

AUTHOR

The construction of the 680 ft. high Bhakra Dam enters the last important phase of concreting on 17th November when Prime Minister Shri Jawahar Lal Nehru threw the first concerte bucket. A concrete mountain will be wedged in the V-shaped gorge at Bhakra which is 1700 ft. long at the top and 300 ft. only at the bottom. The width of the Dam will be 1310 ft. (including apron) at the bottom and only 30 ft. at the top. The total quantity of concrete to to be used is 5.1 million cubic yards which is next only to that used on the Grand Coulee Dam in the U.S.A. An idea of the hugeness of the quantity involved may be had from the fact that it is three times the total quantity of material that went to make up all the seven pyramids of Egypt. Looking at it in another way, we may say that this huge quantity would have sufficed to build a 20 ft. wide road from Delhi to London.

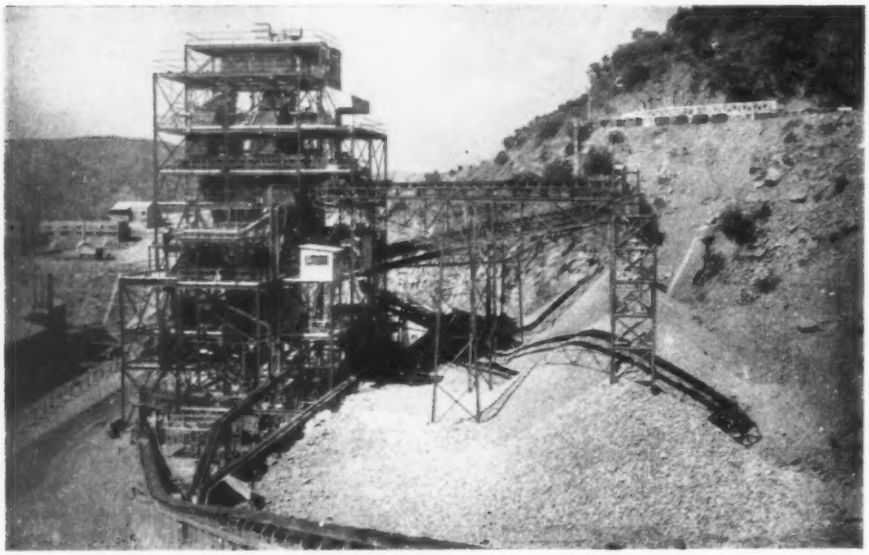
Owing to the fact that huge quantities of concrete have to be put in as expeditiously as possible, it has become necessary to mechanise completely all the processes of concreting, starting from the transporting of material from the quarries to the pouring in and settling of concrete. An elaborate concreting plant has, therefore, been devised to meet the requirements. This plant is similar in design to those used on other high Dams in the U.S.A. like the Shasta and the Grand Coulee Dam. In fact, the plant at Bhakra has been considerably improved upon, and it is, therefore, more elaborate and efficient than any used ever before. This plant is the first of its kind in Asia. This is designed to give 400 tons of ready-made concrete every hour. The designing of the various component parts of this plant has been carried out by our young engineers themselves who have in this way not only added to their knowledge and experience but helped considerable saving in cost.

The sand and gravel as found in the quarries located within a distance of 4 miles from the Dam site, is carried to the destination on the belt conveyor at the rate of 750 tons per hour i.e. almost a train load every hour. The belt conveyor consists of a series of belts made of rubber and canvas placed in succession with each other and supported on rollers provided with ball-bearing arrangement to reduce friction on revolving. The length of each belt varies from 200 ft. to 800 ft. and circles over two pullies one on each end. At one end of the belt is fitted an electric motor with a reduction gear which sets the belt in motion.

The belt conveyor carries material to the Aggregate Classification Plant where sand and gravel are separated into various required grades. The screening plant is a 125 ft. high structure provided with 4 sieves of different sizes. The gravel is sorted out in 4 different sizes varying from 7″ to 3″, 3″ to 1½″, 1½″ to ¾″ and ¾″ to 3/16″. Fine sand below $\frac{3}{16}$″ size is separately subdivided into 7 different grades. Required quantities of each size of sand and gravel are taken along the belt conveyor to the Batching and Mixing plant for concrete formation. But before gravel is taken to the Mixing plant, it is allowed to remain for half an hour at the cooling plant in huge containers filled with circulating chilled water at 34°F. Thus the temperature of gravel is reduced to about 43°F before it is mixed to form concrete. The belt conveyor coming out of the cooling plant passes through an insulated chamber till it reaches the Batching and Mixing Plant. This has been done with a view that the cooled aggregate may not draw heat from the atmosphere and that the final temperature of the concrete formed should not exceed 65°F at the time of placement in the Dam. The precooling of the aggregate is essential in order to prevent high rise in temperature as a result of the chemical action of cement which might otherwise cause cracks in the huge concrete structure.

About 800 tons of cement will be needed daily which will be brought from Surajpur cement factory in special box type steel wagons. The cement on arrival at Bhakra Dam will be pumped into six silos each of 850 tons capacity. From here cement will be again pumped up by air pressure through pipes to the Batching and Mixing Plant where the various ingredients will be automatically weighed according to predetermined proportions. There are about 10

Vishnu Dutt is *Public Relations Officer, Bhakra Nangal Project.*



The 125-feet high structure of the Screening Plant, screening gravel into 4 heaps of different sizes.

or 12 different types of mixes and the pressing of a switch corresponding to each mix will do the trick. There are 4 mixers each of 4 cubic yards capacity which would empty out their contents at an interval of 45 seconds. A rail car fitted with four buckets waiting below the mixers will carry away the concrete after every three minutes and reach the Dam site along railway tracks laid on 300 ft. high trestles. A huge double cantilever crane having a long boom of 165 ft. and other cranes will be following the rail cars and lift the bucket and lower them into the

A section of the Belt Conveyor at Bhakra showing the gravel being transported and dropped into a heap.

required position. Electric vibrators having 7000 vibrations per minute will be constantly shaking the concrete and settling into blocks of nearly 100′×50′×6′ size.

Cooling pipes will be installed in the blocks of concrete in the Dam to cool down the concrete by circulation of cold water.

Coppers seals will be provided at the junctions of the blocks to prevent any leakage of water through the joints. Finally the joints of the concrete blocks which would have sufficiently opened due to construction of concrete on cooling will be grouted with cement to make a compact structure.

In order that the concrete dam might have the requisite strength and stability to be able to withstand the tremendous pressure of the huge reservoir of water (7.4 million acre feet), it is necessary that the concrete should be of the best available quality. Its low cost is another consideration that has to be kept in view. It may be mentioned that even the slighest economy effected is bound to assume colossal proportions on the whole. For example, even if half a bag of cement per cubic yard of concrete is saved, the total saving effected on that count alone would be about rupees one crore.

A Concrete Research Laboratory at Nangal has been established precisely for the above mentioned purpose. It is fully equipped with the latest type of equipment to carry out scientific investigations. Researches on various types of concrete mixes and their constituents are carried out to determine their strength and durability keeping in view the economic factor as well. The results obtained in the laboratory are applied on the field with advantage so as to derive the optimum value from the available material.

In the interest of economy, it is necessary that so far as possible material locally available should be utilised for concrete formation. The Laboratory has stood in good stead in determining the sand and shingle locally available in the bed of the river near Fatehwal and Neilla, within a distance of 4 miles

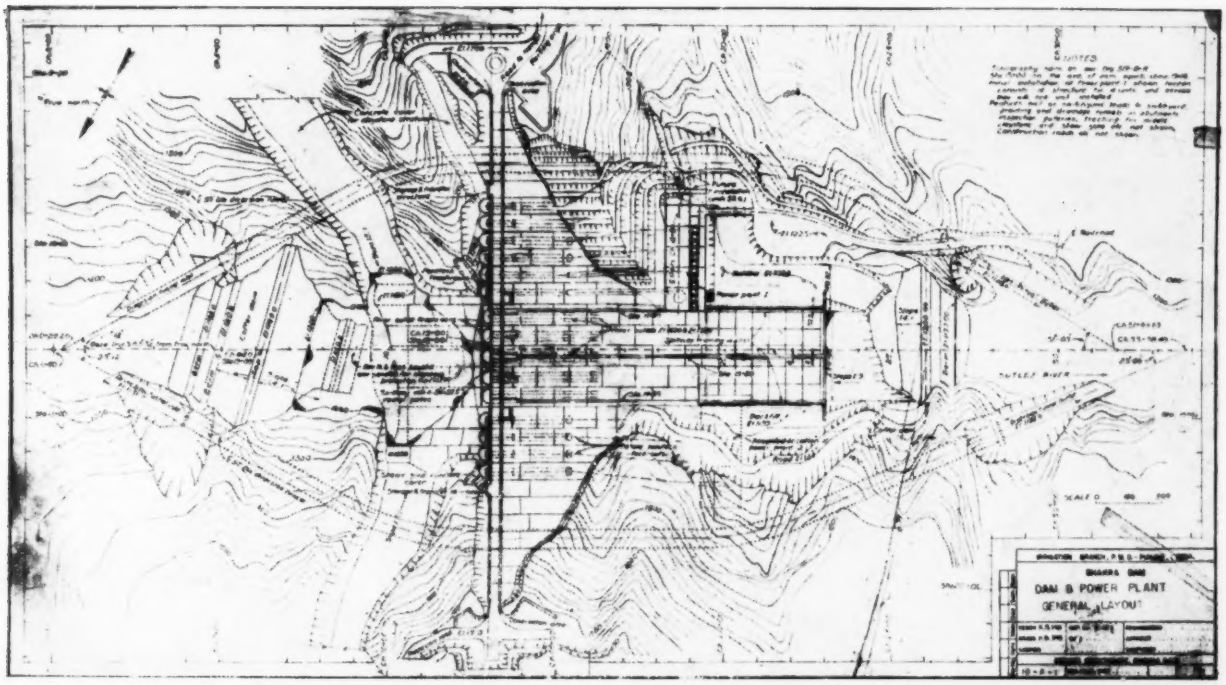
A view of the plant area at Bhakra showing the Belt Conveyor leading to Screening House and the Cooling Plant. In front are six cement silos for storage of cement.

only from the Dam site, are ideally suited for formation of concrete. This has helped in keeping down the expenditure considerably.

Aggregate, fine and coarse commonly known as sand and shingle respectively, are one of the constituents of concrete. With a view to their selection, it is important to study in detail their various chemical and physical characteristics. It has been observed that premature deterioration of concrete in various cases has been due to use of unsuitable aggregate Final selection of aggregate is made after determining its unit, weight, specific gravity, weathering properties, crushing strength, its chemical reaction with alkalies present in cement and other physico-chemical factors.

As a result of investigations carried in the Laboratory, it has been found that the smooth rounded stones found in the bed of the river, technically known as "quartzite stones" are ideally suited for concrete formation. Four sizes of stones from 7" to 3/16" have been determined to be used for concrete formation of different types. Luckily stones of all these sizes are available in the natural state as found in the bed of the river. Similarly, seven different types of grades descending from 3/16" downwards have been determined to give ideal sand. Sand of the required

Bhakra Dam—General Layout



A view of Bhakra Gorge where the Dam is being constructed. The river may be seen emerging out of the Diversion Tunnels.

grades and quality is also available in the same quarries from where stones are to be obtained.

The design of concrete mixes involves the determination of most economical combination agents that will produce a mixture having the desired workability and will develop the required qualitites on hardening. By using the trial batch method in the laboratory, optium proportions of various ingredients required for 10 to 12 different types of concrete at Bhakra Dam, have been established. Various tests on plastic and hardened concrete are conducted. Some of these tests relate to workability, cohesiveness, compressive strength, flexural strength and modulus of elasticity.

Of late it has been conclusively proved that the presence of small air globules in the concrete structure improves its quality in so far as its imperviousness and resistance to weathering conditions are concerned. The small disconnected air-voids embedded in the concrete offer a barrier to the passage of water thus rendering it more impervious to water than ordinary concrete. Durability of concrete with entrainment of air is increased at least five times as compared with that of ordinary concrete.

The entrainment of air also greatly facilitates the handling and placing of concrete, the air globules acting as so many ball-bearings on which the mass of concrete slides with ease and rapidity. The time saved in placing, handling and finishing the concrete more than offsets the cost for air-entraining agent used, thus rendering it ultimately more economical. Moreover each per cent of the air entrained permits a reduction in mixing water from 2 to 4 percent. This results in the saving of cement without any detriment to the workability and strength of the concrete. Vinson Resin to be imported in powder rather than liquid form is the air-entraining agent being used for this purpose.

Other efforts being carried out relate to the possibility of partial replacement of cement by any other suitable material which is less costly. The researches so far carried out have established that if 20 per cent of the cement is replaced by calcined shale, there is not only no deterioration in the quality of concrete ; on the other hand, there is considerable improvement in so far as its workability, plasticity, and segregation are concerned. There is also increased imperviousness in the finished concrete and there is lower heat of hydration. Shale is available in abundance in Bhakra gorge itself. Researches have shown that shale is most effective when it is calcined at a temperature of 1400 degrees F. and pulverised to a fineness greater than that of cement. The cost of calcined shale is much less than that of cement, and there would be considerable saving if ultimately it is decided to use this new product.

It is believed that best quality concrete will be used at Bhakra Dam and that its cost will be cheaper than anywhere else of similar works in India. The concreting operation shall continue till the close of 1959 when the Dam is scheduled to reach its maximum height.

We invite you to visit the U.S.S.R. Pavilion at the Indian Industries Fair, New Delhi.

VSESOJUZNOJE OBJEDINENIJE

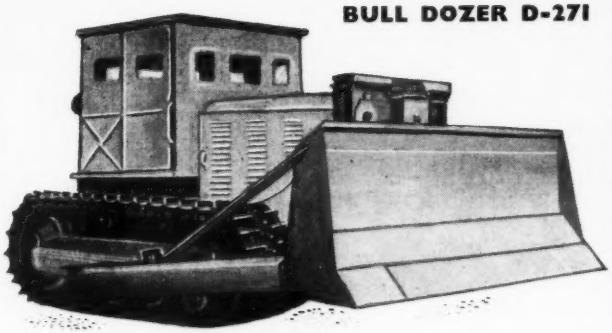
TECHNOPROMIMPORT

32/34, Smolenskaia–Sennaia Moscow G–200, U.S.S.R.

EXPORTS: EFFICIENT & ECONOMICAL

ROADMAKING AND EARTHMOVING MACHINES

BULL DOZER D-271



AUTOMATIVE ROAD ROLLER D-211

Bull Dozers, Scrapers, Graders, Road Rollers, Caterpillar & Wheel Type Tractors Of Various Models & Capacities, Bitumen Spreading Trucks, Etc.

ALSO EXPORTS

Agricultural Machinery & Implements, Motor Cycles, Trucks Of Various Types & Capacities, Auto & Trollybuses, Telephone, Telegraph & Radio Equipment, Electrical Measuring Instruments.

For further particulars please write to :

TRADE REPRESENTATION OF U.S.S.R. IN INDIA

NEW DELHI

House No. 21, Block No. 48,
East West Road, Chanakya Puri.

BOMBAY (Branch) 46, Pedder Road.

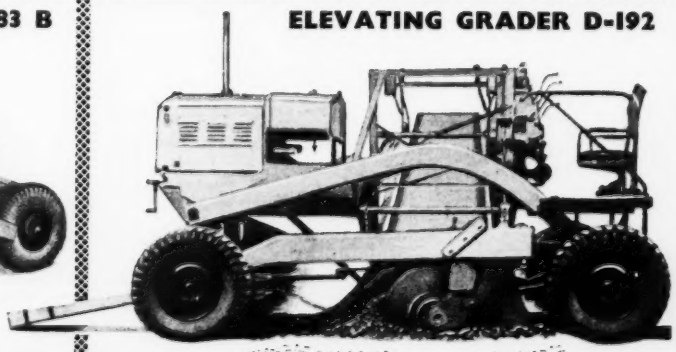
CALCUTTA (Branch) 4, Camac Street.

Showrooms: "VASUNDHARA"

Bhulabhai Desai Road, Bombay 26.

SCRAPER D-183 B

ELEVATING GRADER D-192

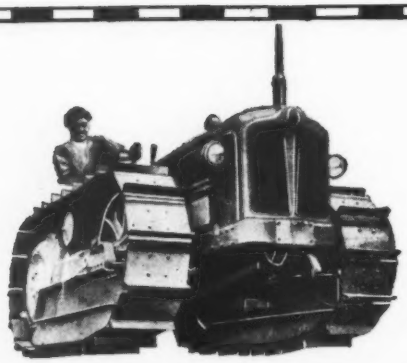


NU29

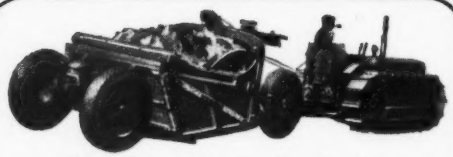
POWERFUL UNION THAT PAYS...

Planning for development and execution of schemes mainly depend on selection of equipment.

Fordson range of equipment and ancillary manufacturers offer the ideal combination that makes every phase of the project work and their allied operations more paying.



The County Crawler is a 40.5 h.p. Tractor with a maximum sustained drawbar pull of 10,500 lbs.



Capacity (S. A. E. Standard)
Struck.....2.7 cu. yards....2.065 cu. metres.
Heaped....3.6 cu. yards....2.754 cu. metres.

U.P.C.C
EVERYTHING FOR THE FARM

Assemblers & Sole Distributors in India.
THE UNITED PROVINCES COMMERCIAL CORPORATION
53, RADHA BAZAR LANE, CALCUTTA-1

P.P.S./F.3.14/MY

D.V.C *Special Number*

of

Indian Journal of Power and River Valley Development

Contributors include Chairman, Members, Chief Engineers, Heads of different Departments of the D.V.C.

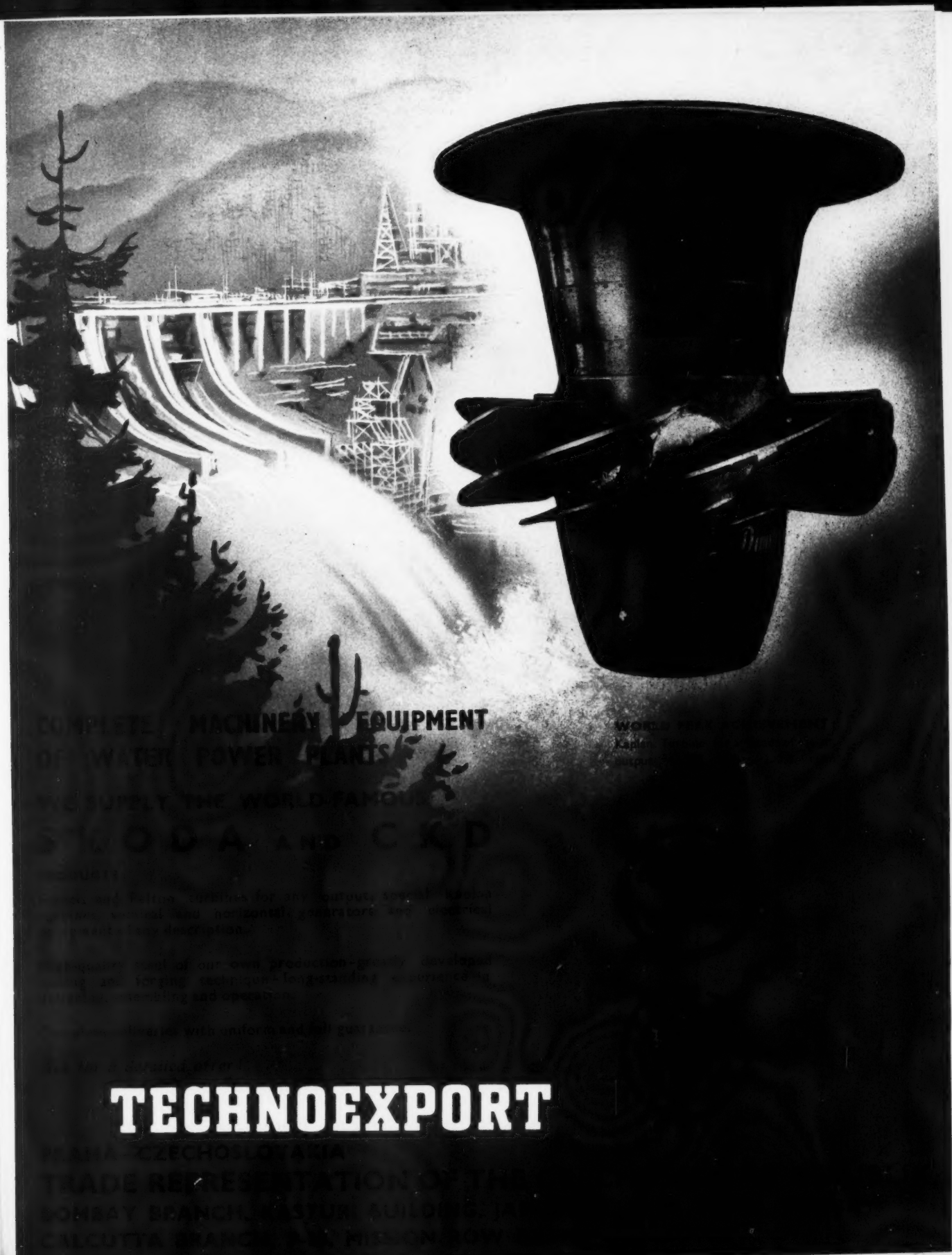
Price : Rs. 5/-

Place your orders with:

The Manager, Indian Journal of Power and River Valley Development,

6/2, Madan Street, Calcutta-13

Phone 23-1765


MACHINERY
EQUIPMENT
PLANTS
TECHNOEXPORT

I tell the stories of the glorious past and the golden future. I flash to the world the news of laughter and of tears. I am the tireless clarion of various river-valley developments.
I am

INLAND PRINTING WORKS

60/3 Dharamtala Street, Calcutta-13

Phone 24-3552.

The Engineer's Contribution to the Conservation of Natural Resources—II

By

SIR HAROLD HARTLEY, K.C.V.O., F. R. S.,

(*Continued from previous issue*)

Land Conservation and Reclamation

I have already touched on the conservation of soil by measures to prevent erosion, flooding and salinity, now I come to the wider problems of land conservation and reclamation. In some places nature is encroaching on the land by coastal erosion, in others she is adding to the land areas by depositing silt at the mouths of rivers. These two effects are said largely to balance one another, but it is the engineer's task to prevent the one and take advantage of the other so as to increase the land area. Coastal erosion is slow but continuous, protection against it is difficult and costly and consequently it is undertaken mainly to protect industrial and residential sites or to guard against the danger of the flooding of large areas of agricultural land by high tides and surges. Jean Ingelow's poem "The High Tide on the Coast of Lincolnshire" gives a vivid picture of what has occurred in the past of which we had a sharp reminder in the disaster of 1953.

Holland more than any country is at the mercy of the sea as 40 per cent of the land is below sea level, and there the techniques of protection by sea walls and sand dunes have been the subject of constant research and study. There again soil mechanics is most helpful and the study of the most effective plant and tree cover is providing the most economical solution. This was dealt with in such detail in the proceedings of your Conferences on "Biology and Civil Engineering" in 1948 that I need only mention here the contribution which these studies are making to land conservation. It is one of the important partnerships of man and nature.

In coastal protection model work again is indispens able in showing the effects, sometimes most unexpected, produced by sea walls or groins so that they can be designed effectively and with economy. The force of water is so strong and its effects so disastrous that the protection of land against floods from sea and river must always remain a major task of the engineer.

At the mouth of some great rivers like the Ganges and the Nile nature through the ages has built up large areas of fertile land in their deltas without the aid of man. But in countries like Britain and Holland where land is precious man cannot wait and must help in reclamation.

In Britain the great reclamation of the southern fens by the "Adventurers" in the XVII century by drainage added 600,000 acres of the most productive land in the country mostly below high water level so that its existence depends on the maintenance of sea walls, river banks and drainage. Since then some 75,000 acres of the Wash have been reclaimed when and where there was a silt deposit covering the sand which justified the cost of a new sea wall and drainage.

The history of Holland is a long fight against a slowly rising sea level to preserve the land by sea and river dykes. The Zuider Zee was lost to the sea as late as the Middle Ages, since when there has been a gradual regain of land by reclamation. Inland lakes have been drained and cultivated and in 1927 the great Zuider Zee project was started and with the closing of the twenty-mile dam across its northern entrance it ceased to be a sea and became a freshwater lake, the Iseelmeer, in the middle of Holland which can supply water to the surrounding districts in prolonged periods of dry weather. This is being followed by enclosing or impoldering five successive areas with dykes behind the dam which will add over half a million acres to the cultivated area of Holland when the water has been pumped from them. The gradual accumulation of silt in these areas is being accelerated by the hybrid grass *Spartina townsendii* imported from England. This grass was first noticed by Lord Balfour of Burleigh in 1899 in Poole Harbour. He brought it to the notice of Francis Oliver who soon realized its potentialities for artificial reclamation as it will rgow in brackish water and by slowing down the currents hastens the deposition of silt and its subsequent consolidation.

The policy of the Dutch has always been to shorten their coast line and the risk of floods, and after the disaster of 1953 they are embarking on the "Delta Project" of building dams across the tideway entrances to the great rivers in the south which when complete will have the coast line that has to be protected.

Another country in which the richest soil is below sea level and must be protected by sea walls and pumping is British Guiana, where the original development made by the Dutch has been maintained by British engineers.

The Imperial Valley in California may before long present a special problem of land conservation. Thanks to irrigation the valley, which was once a desert, is now most fertile, growing 3 to 4 crops a year. The whole of it is below sea level and it owes its protection against the Pacific Ocean to the natural barrier which had been created by the deposits from the Colorado River in former ages. Each year the coast erosion removes a large amount of the barrier, but until recently the barrier has been maintained by the silt of the Colorado which balanced the erosion of the sea. Now that the silt is being deposited in Lake Mead the barrier is being gradually reduced. In 1940, only five years after the construction of the Boulder Dam, the Gulf of California had advanced by 25 kilometers This is another case of man's interference with nature, and the problem is made more difficult by the fact that the erosion is taking place, not in the United States, bus on Mexican territory.

And next there comes the cultivation of the land, when conservation means the raising of crops without the loss of soil fertility It is only too easy to raise crops at the cost of fertility. And here since mechanization has invaded agriculture the task of soil conservaton falls largely to the agricultural engineer. Britain has now the most highly mechanized farming in the world, and thanks to this the annual productivity is £660 per man employed.

Every type of soil and climate presents a special problem and it is for the engineer to provide the implements and methods which will optimize the yields of crops while maintaining the fertility of the soil. Water again is the limiting factor and I have already touched on the great economy and advantages of spray irrigation which we owe to the engineer. Its great advantage is that it can provide the right amount of water when it is needed. Penman has shown that the loss of water from the soil by transpiration depends mainly on solar radiation and in Britain this corresponds closely with the sun hours per month. The Meteorological Officer now publishes monthly potential transpiration figures for the more important farming districts of the country to help farmers in deciding how much water is needed to make up for deficit in rain. So that with spray irrigation the use of water becomes more scientific and economical and the size of droplets can be regulated not to exceed 2 mm, in diameter, as large drops break up the soil particles and consolidate them reducing the porosity of the soil. The provision of economical drainage is another problem for the engineer.

We are learning gradually how to make the best use of nature's gifts and under what conditions land is best devoted to forestry, grass cover or arable crops. In all this engineering and soil machanics are vital factors and on the engineer's contribution to mechanization and conservation will depend more and more the ability of the world to feed itself in the future years.

Energy

Next to soil and water I rank energy as the third great need of mankind since statistics show that the consumption of energy per capita determines the the standard of living of a country. Here the engineer by the increasing use of water power is drawing on revenue and not on a capital resource, though water power only provides 4 to 5 per cent of the world's energy consumption. Other revenue resources are solar radiation, wind, tidal energy, geothermal heat and the burning of timber and vegetable products. The latter source provides some 18 per cent of the total energy consumption today and there is not much prospect of any considerable contribution from the other revenue sources in the near future. Geothermal schemes in Italy and now in New Zealand are of local importance and the Bell Laboratory solar battery with a 10 per cent efficiency of conversion of solar radiation energy to electricity points the way to important developments.

The main contribution of the engineer hitherto has been the steady rise in the efficiency of combustion appliances, in the generation of electricity and and in the gasification of coal. In the United Kingdom the increased demands for energy between 1920 and 1937 were met almost entirely by increased efficiency of energy conversion and utilization representing a saving of at least 40 million tons of coal. There is no need to stress the importance of a continued effort for higher efficiency but fortunately the possibilities of the nuclear power station have come just when there is little prospect of large additions to the output of coal. Here again is a combined operation for the electrical, chemical, mechanical and civil engineer which will add a hundredfold to the world's resources. Important as electricity is as a source of heat and power, our economy is linked in many ways with liquid fuel, and the coming of nuclear power will enable the coal and oil resources to be used in the future more as a source of chemicals and of the liquid fuels on which for many purposes our economy is based.

We shall watch with envious eyes the great Sasol plant in South Africa just coming into operation to make petrol and other products from the cheapest coal in the world costing 3/6d per ton.

Raw Materials

I come last to the engineer's contribution to the conservation of raw materials by added efficiency in their extraction, processing and use. It is a long story which might easily become a wearisome catalogue, so let me select some of the outstanding examples and particularly those of special significance for the future.

Extractive Metallurgy

We are living in a metal civilization and in spite of the progress that is being made in the use of plastics and bonded materials as substitutes we must took to an increasing use of metals in the future. For many

engineering purposes they are indispensable, and progress in metallurgy is often the limiting factor in engineering design. All recent surveys of resources like the Paley Report make it clear that we shall become increasingly dependent on lower grade ores, often containing several finely intergrown minerals which must be separated. For the treatment of such ores the older physical methods of ore dressing producing concentrates for smelting are proving inadequate and they are now being supplemented by various chemical engineering techniques There are two main developments, in one the metals are leached out by various solvents, sometimes under pressure, and are then separated by different methods, preprecipitation, electrolysis or solvent extraction as in the case of uranium. For example a large ore deposit containing less than one per cent of copper oxide is being leached with sulphuric acid. Bacterial oxidation of a low grade, partly oxidized, copper sulphide deposit is being tried with the same object. Nickel sulphide concentrates are being leached with aqueous ammonia and oxygen under pressure.

The other method consists in treating ores in fluidized beds at controlled temperatures with various gases. Iron oxide can be converted to mgnetite for magnetic extraction, and sulphide of copper, nickel and cobalt can be roasted to sulphates for subsequent leaching with water. By temperature control an almost complete separation of copper from iron can be effected in this way. A number of methods are being investigated for the extraction of manganese from low grade ores and open-hearth slags.

The use of active carbon to extract metals from dilute solution has also considerable possibilties. For instance gold can be extracted continuously with economy in the amount of cyanide required, and a considerable saving in the number of thickeners and continuous drum filters which are needed when the gold is recovered by precipitation with zinc dust.

The United States Bureau of Mines is carrying out large scale experimental work on the chemical treatment of low grade manganese ores by sulphating followed by leeching and precipitation. There are also possibilities of recovering manganese from slag by fluidized bed roasting followed by extraction with ammonia and ammonium carbonate.

Another important aspect of the chemical approach in attacking ore treatment problems is the extraction of values from the slimes which are often unavoidable and may carry sufficient of the ore to prevent the economic exploitation of a low grade deposit. Selective flocculants are giving promising results and polyvalent ions are being used as flocculants in the recovery of uranium from enormous quantities of slimes from the treatment of Florida phosphates.

These new methods are likely to extend greatly the range of the ores that can be treated profitably and thus increase the potential resources of metals in the world.

Hitherto most of the development work in this new field has been done in the United States and Canada where the exploitation of mineral wealth is a major part of the economy. The old distinction between the processes used in ore dressing and extractive metallurgy is disappearing with these chemical methods of ore treatment. In the future there must be a much closer link between the schools of mining and chemical engineering in this country if we are to keep abreast of the times.

The Processing of Raw Materials and Synthetics

There is no better example of the great advances that have been made in the scientific processing of raw materials than the improvement in the refining of crude oil over the past 30 years, and it was responsible for the introduction of the fluidized bed, one of the revolutionary advances in modern techniques. By the improved design of stills, by better control and heat recovery, the overall thermal efficiency has been raised by 25 per cent, the amount of refinery fuel required being less than 2 per cent of the crude oil distilled. Then the amount of motor gasoline produced today by thermal reforming, catalytic, cracking, polymerization of olefines and other new techniques is on a world basis 36 per cent by weight of the crude as compared with 18 per cent by straight distillation 30 years ago, and the octane number of the gasoline is much higher with the resulting improvement in fuel economy.

Further there has been a great increase in the range of products and their quality to keep pace with technological progress, for instance in the development of aero-engines. Synthetic detergents, paint additives, cutting oils and an immenese range of lubricants are among the most significant advances. Propane and butane are sold as "bottled gas" instead of being burnt as refinery fuel. A new aliphatic chemical industry has been based on refinery gases, and platforming adds largely to the supply of aromatic chemicals like benzene which are now in such great demand.

There are many other parallel examples of this trend of modern industry to make better use of its new materials—rubber, cellulose, leather and above all perhaps in importance, the scientific processing of food, which is now a great industry which contributes so much to its preservation and economy.

Synthetics in the XX century have done much to change the pattern of our life and synthetic ammonia has relieved our anxiety about nitrogen fertilizers, which by increasing the output per acre are a most effective means of conservation. Plastics and synthetic fibres not only supply many new needs, but as substitures for vegetable products they relieve the demand for them and thus leave more soil for food

production. The output of rayon and viscose already exceeds that of wool.

But man's power to synthesize materials economically is limited to simple molecules and their polymers. There is no hope of his manufacturing the complex proteins and polysaccharides he needs for food without the aid of living organisms, who make them so accurately and cleanly by their template methods. Fermentation is one of the oldest industries but it is only in this century that microbiology has revealed the almost unlimited possibilities of the living cell. From Pasteur and Kooh the microbe got a bad name, but without it life on this planet could not exist. The microbe is a great conservationist and it deserves a better reputation. The amount of nitrogen supplied to the soil each year by fertilizers is only a small fraction of that fixed by living organisms in the soil.

Rahn in a comparable study of the criminology of the microbe and mankind in the United States concluded that only one micro-organism in 30,000 was a carrier of disease, while in the year of his census one inhabitant in 17,000 was convicted of murder. And as Professor Kluyver pointed out in his Leeuwenhoek Lecture the amount of microbial protoplasm in the world is probably 20 times as great as that of animal protopasms, so there is no lack of ready helpers with an amazing adaptability The harnessing of micro-organisms in the production line in friendly tasks is one of the great ventures of the near future—biochemical engneering.

Structures

Among the great economies in the use the engineer makes of materials I put structures high on the list. I remember seeing in 1901 the first skyscraper in New York, the old Flat Iron Building, soon to be dwarfed by the giants of that amazing skyline of Manhattan Island. The foundations of these great modern buildings are based on site studies using the techniques of the new science of soil mechanics. I have already touched on some of its new methods which are applied to big dams, and as Dr. Lea dealt with them so thoroughly in his recent Unwin Lecture I need only refer you to this for the scientific methods that are now available to investigate the sub-soil characteristics and the various techniques for designing and constructing the foundations on which buildings can be erected with economy and security. As a matter of interest I got the costs of a number of these site studies and they averaged about 0.2 per cent of the cost of the building, some being as low as 0.03 per cent, showing the small addition these invaluable studies make to the total cost.

Then in the structures themselves steel reinforced concrete with pre-stressed and often pre-cast units, have made the main contributions to new designs and economies. Progress in the theory of structures based on the elastic limit of materials, in the quality of steel and in the fabrication of steel members, and especially long experience, have produced large savings in the amount of steel required and the cost of erection. I have a special interest here as one of the three steel framed buildings which Dr. Baker, as he then was, investigated for The Steel Structures Research Committee, was one in which I was responsible for the co-ordination of the architects and the engineers. That investigation illustrates a principle I should like to adumbrate. Every major engineering project should be treated as an opportunity for research with the necessary scientific measurements in order to correlate the predictions of design with the results obtained, and to point the lessons for conservation. We did that at Euston House.

The results of Professor Baker's investigations showed the limitations of the elastic theory for practical use owing partly to its complexity in large structures and partly to the discrepancies observed in the stresses in the framed structures due to the vagaries of rivetted and bolted beam-to-structure connections. In structures designed by the elastic theory, some deformation must occur at working loads due to stress concentrations and lack of fit during erection. Were it not for the ability of mild steel to undergo plastic deformation, such structures would prove unsatisfactory in service.

Professors Baker's development of the plastic theory of structures provides a basis for design in the calculation of ultimate strength and in so doing forces a realistic appreciation of the importance of ductility. One of the most important consequences of basing design on ultimate strength is that full use can then be made of the advantages of redundancy and of the rigid joint construction made possible by the modern development of welding. This leads on to the consideration of load factors instead of the old-fashioned factors of safety. Experience in the erection of single-storied buildings designed on the basis of the plastic theory shows economics of 15 to 30% as compared with similar buildings designed by orthodox elastic methods. The plastic method not only makes it possible to design buildings more economically but opens the way to the development of new steel structural forms.

The increasing use of concrete in structures has helped the conservation of resources in two ways. First by its use in conservation schemes like coastal protection, harbours and dams. Secondly by the use of less valuable and more generally available raw materials in place of steel, with a consequential economy in coal.

A reinforced concrete structure requires about 40 per cent of the weight of steel compared with a normal steel structures and the use of prestressed concrete in flectional members requires about one-seventh of the steel. In some structures (e.g. multi-storey buildings) the extra concrete required is almost negligible but in others (e.g. bridges) the saving in steel has to be off-set by an increase in the use of

cement and aggregates. Even here, however, it may not be more than about 25 per cent because the same amount of concrete is used for the foundations in both instances.

The economy of coal follows since 35 cwt. of coal are needed to make a ton of steel and 8 cwt. to make a ton of cement. To the latter must be added the coal equivalent of the energy required in providing the average amount of 4 tons of aggregate which must be added to one ton of cement in making concrete. As a rough guess the replacement of a ton of steel by a ton of reinforced concrete saves about a ton of coal.

The Working and Fabrication of Metals

I turn now to the great economies in material and effort that have resulted from the scientific development of the methods of working and fabricating metals and testing the quality of the product. The improved methods of welding, casting, pressing, extrusion, oxygen cutting, and machining have revolutionized metal fabrication, and the use of X-rays, gamma-rays, supersonics and other devices have enabled the products to be tested with much greater certainty. This is a steel age and the efficiency of the modern steel works and the continuous strip mill is a great contribution to our economy.

Welding has had the most widespread effect in the ubiquity of its applications both to fabrication and repair. With the mechanization of farming, just think of the value of an electric welder in repairing quickly a defect in a harvester in the critical days of gathering crops, and the other applications of welding to repair are manifold. The various forms of electric welding, D.C., A.C., oxyacetylene, argon arc, nitrogen arc, spot welding, and butt welding have made it applicable to almost every metal, have saved immense amounts of material and have simplified construction by elimination the need for rivets,gussets and overlap. In steel-framed building there are economies in materials up to 25 percent and the absence of rivet holes means that design can be based on the full sectional area of tension members. Welding is essential for the use fo plastic design methods which requires that all joints must be compeletely rigid. In bridges welding may show a saving of 25 percent over a riveted design and a transfer of many tons to the permissible live load. In ships there may be economies up to 17 percent of weight for an 18,000 ton tanker with welded construction, with the advantage of the smooth contour of the welded hull and a corresponding saving in fuel consumption. The substitution of the welding for the forging of pressure vessels has not only cheapened production but has made possible many improved designs.

Next to welding improved precision methods of casting have contributed to great economies:- centrifugal casting, die casting, shellmoulding, and the elegant lost wax investment method for small castings. In the latter a pattern is made by injecting wax into a die, the wax is then cooled with a fine refractory and bonding agent and invested with a slurry of refractory which sets to form a mould. The wax is then melted out, the mould is fired and used for pressure casting. By this means intricate precision castings can be made with a fine finish with a great reduction in the machining required and an average saving of material of 50%. Gas turbine and jet engine compressor blades with their complex aerofoil sections and shapes can be made in this way much more cheaply than by machining them out of solid bars. The centrifugal casting of pipes gives a more uniform thickness of sounder metal and a high yield. Bearing metal liners can be cast in by this means requiring little or no final machining.

Improvements in machine tools have led to savings of labour rather than direct savings of material, to greater accuracy and to fine surface finish. Higher cutting speeds to take advantage of carbide-tipped tools and also greater flexibility of speed have been obtained by direct electrical drive with higher powered motors. Higher speeds and improved quality of the products have also been helped by research into the form of the cutting edge of the tool and by the provision by the metallurgist of new alloys better suited both to machining and to the work they have to do. While there has been much progress in automatic machines, the inclusion of the copying principle on standard machines has given them greater versatility and allows of repetition production at high speeds for large or small batches, when the use of a fully automatic machine would not be economical. Improvements in casting and drop forging enable work to be transferred directly to precision finishing machines with a high degree of accuracy.

The latest development is the automatic machine with electronic control and a computor which can read a drawing and translate it directly into work, pointing to the automatic factory of the future.

Wear and Corrosion

One of the major fields in the conservation of metals is in the application of research to the problems of wear and corrosion. Bowden in his Hawksley Lecture showed how the contact of two metal surfaces invariably results in a transfer of particles of one metal to the other and described the conditions under various types of lubricants can minimize this tranfser and loss of material. The action of the lubricant in diminishing friction results in a saving of energy, friction in a motor car absorbs 20 per cent of the motive power, but the major contribution of lubrication is in the saving of wear and in prolonging the life of the moving parts. The possibility of higher speeds and higher bearing temperatures has been made possible by the discovery of lubricants which are stable over a higher range of temperatures like the silicones and ploy fluorethylene and the use of bearings made of sintered metals like copper which can carry the liquid lubricant. Similarly improvements in cutting liquids to remove the heat generated

by the plastic deformation of metal by the machine tool and diminish friction have helped in the high speeds, in the life of the tool and in the quality of the machined surface.

Astronomical estimates have been made of the loss of metals, particularly iron and steel, by corrosion. With the increasing amounts of metal going into service and the growing use of thinner sections, for instance in the steel pipelines that are carrying oil and natural gas many thousands of miles, protection against corrosion becomes increasingly important to guarantee the long life of these costly installations. Much progress has been made in methods of pre-treatment, in the application of protective coatings and wrappings, but the possibility always exists in a long pipeline of weak spots where corrosion may begin. Here as with steel structures under water with ships the use of cathodic protection on an engineering scale either by sacrificial anodes or by an impressed electromotive force is adding greatly to the life of these structures and avoiding very costly failures and replacements. Cathodic protection was invented by Humphry Davy in 1825 but it is only now coming into general use on an engineering scale. He applied it to the protection of the copper hulls of warships, but the Admiralty discarded it as it encouraged the growth of barnacles. It is sad to remember that Davy left England under the strain of the disappointment and public criticism and died abroad, seeking the consolation of a philosopher in travel. Today his invention is a major factor in conserving engineering structures.

The Conservation of Human Labour

I have left to the last the engineer's conservation of human effort, both manual and mental, by mechanisation, automatic control and electronic computors. In the race for productivity mechanisation is the pace maker. Recent figures from the United States show that the productivity per head has doubled with the doubling of the horse power employed. And now a new factor is coming in, as automatic control not only replaces manpower and accelerates production but its products are of higher quality. Electronic devices are much quicker and more accurate than the human brain and can be used for an infinite variety of control purposes. And whereas the human senses can only deal with one operation at a time, an electronic system can regulate simultaneously the many interlocking controls required in a large plant. The nation-wide automatic dialling system of telephones in the United States is a good example. Then analogue computors can simulate complex operating problems and provide a short cut to the answer, digital computors can solve in a few minutes differential equations which would otherwise require a prohibitive number of manhours of work.

There is no need to dwell on the contribution of mechanization to the economies of the production line. Automatic control is another story. On the one hand great progress has been made in the mathemetical theory of control design which is directly applicable to the design of control equipment for systems in which the dynamic characteristics of the mechanisms are known. On the other hand progress in instrumentation and in the technique of servo-mechanisms has led to the widespread application of automatic control to machines and continuous processes which were not originally designed with this in view. If the maximum advantage is to be made of this new approach, its philosophy and theory must start in the design phase and be applied continuously. This entails both an appreciation by the designer of its possibilities and the co-operation with him at each stage of the control engineer who has specialized in control theory and instrumentation. A big educational problem is involved which is vital to the industrial future of this country, ecpecially now that full employment has been reached.

Information from the United States and the Soviet Union is strong evidence of the much greater awareness of the urgency of this problem in both these countries. In the United States there are said to be close on 2,500 companies in the control business employing 8,000 graduate engineers who have specialised in this field, and there are 15,000 more in the user industries. Russia has concentrated her mathematical ability on the theory of automatic control and her numerous applications of it in industry show how effectively she has grasped its philosophy. She was operating in 1951 the first complete automatic production line of an alluminium alloy piston from the ingot to the finished product fully tested and examined, and she had automatic plants making cylinder blocks in 1948 and also agricultural machinery. Her automatic tests of surface finish are most effective and ingenious. Evidently her objective is high quality machine production using a minimum of skilled personnel, thereby increasing her competitive position with the other great industrial powers of the world. This is the Russian engineer's contribution to conservation.

I do not wish to end this review of the engineer's achievements on a gloomy note so far as Britain is concerned, but in spite of the interest shown by a few firms, I must draw attention to the urgent need for a more active and general recognition of the future importance of control engineering in this country.

Conclusion

And now what emerges from this patchwork survey of the engineer's massive contribution to conservation, the need for which will increase with the growing population of the world and the depletion of its capital reserves? I said at the end of my James Forrest Lecture over 20 years ago "Progress today demands intense specialization on the one hand and on the other the widest outlook and knowledge of what is happening in other fields—intensive research and extensive application." And this is even truer

(*Continued on page* 14)

Gas Turbine Power Plants in Operation

By

LEO WALTER A.M.I.Mech.E., M.Inst.F.
Consulting Engineer

AUTHOR

Although it seems still much too early to give a final verdict about the comparison of thermal efficiency, economy and reliability of modern industrial gas turbine plants versus steam-electric plants, or versus reciprocating oil-gas engine plants, certain basic facts have emerged from the operational reports available from makers of gas turbines. Being in its infancy the stationary industrial gas turbine does not lend itself at the present time to many critical observations and teething troubles in operation seem unavoidable for a new machine type. Developments in designs of the various makes of gas turbines as prime movers and of whole gas turbine power plants are still vigorous. It may well be that very novel design features might alter the whole picture within the next years, and will probably widen the field of practical applications.

The factors which influence the choice of a gas turbine as prime mover are partly technical; such as design, installation, operation and maintenance; and partly economical; such as first installation cost, and running and maintenance costs. Other factors can greatly influence an ultimate decision to choose a gas turbine for generation of electrical power, sometimes combined with useful utilization of waste heat for an industrial plant. The above factors will be briefly reviewed in the following. As this can only be done in a very general way, no hasty conclusions should be taken by a potential user or interested plant management, especially where economy is concerned, which latter largely depends on cost of fuel available and on running and maintenance cost.

Plants in operation

There seem to be at the time of writing about 125 stationary gas turbine plants in actual operation in various countries such as Great Britain, Switzerland, U.S.A., France, Sweden and Italy. All these gas turbine plants have different working conditions, and load varies from 1200 kW to 27,000 kW per unit. Some plants are used for "topping" existing steam or hydraulic power plants, others work continuously under average load, and others are stand-by units. Fuels range from light and heavy fuel oils to natural gas, blast furnace gas, and as experiments, peat and pulverized coal. Inlet temperatures for gas vary but 750° C at the turbine inlet is in use in U.S.A designs and seems to be allowable for continuous operation under certain conditions (Fig. 1.)

Developments in recent years gradually increased capacity per unit to 10, 15 and 20 MW using single-compression, and to 25 MW and over for two stage compression. Contrary to the general assumption that the industrial gas turbine is essentially a large prime mover, some trends have become recently visible for developments of very small gas turbine units for operation of pumps, fans and the like. The light weight of small gas turbines might easily make it paramount for portable units.

Switzerland was the first country in Europe to develop stationary gas turbines, and can therefore look back at several practical operational results which deserve earnest attention. Firms like Sulzer, Oerlikon, Escher Wyss & Co. and Brown Boveri & Co., of Switzerland are amongst the pioneers.

Operational results

The Swiss firm of Brown-Boveri and Company A.G., Baden, mentions the following gas turbine plants in operation. As early as November 1936 a simple cycle turbine (Fig. 2) went into operation at the power plant at Marcus Hook of the Sun Oil Company, Philadelphia, U.S.A., and since then four different sizes of this type have been built for oil refineries. Table I sets out operational data for six of these machines, having capacities from 300 to 1000 kW. One of the first of their power plants for emergency use was installed in 1939 at Neuenburg, Switzerland. It was started automatically with the exception of ingition and ran in parallel. It is claimed by the makers that in from 8 to 12 min. the set operates at full load. Table II sets out data for sudden load changes for this stand-by gas turbine plant, derived from actual operation. Fuel is a light fuel oil necessitating no pre-heating.

Another plant started operation in 1949 at Chimbote in Peru, South America, using a gas turbine set of

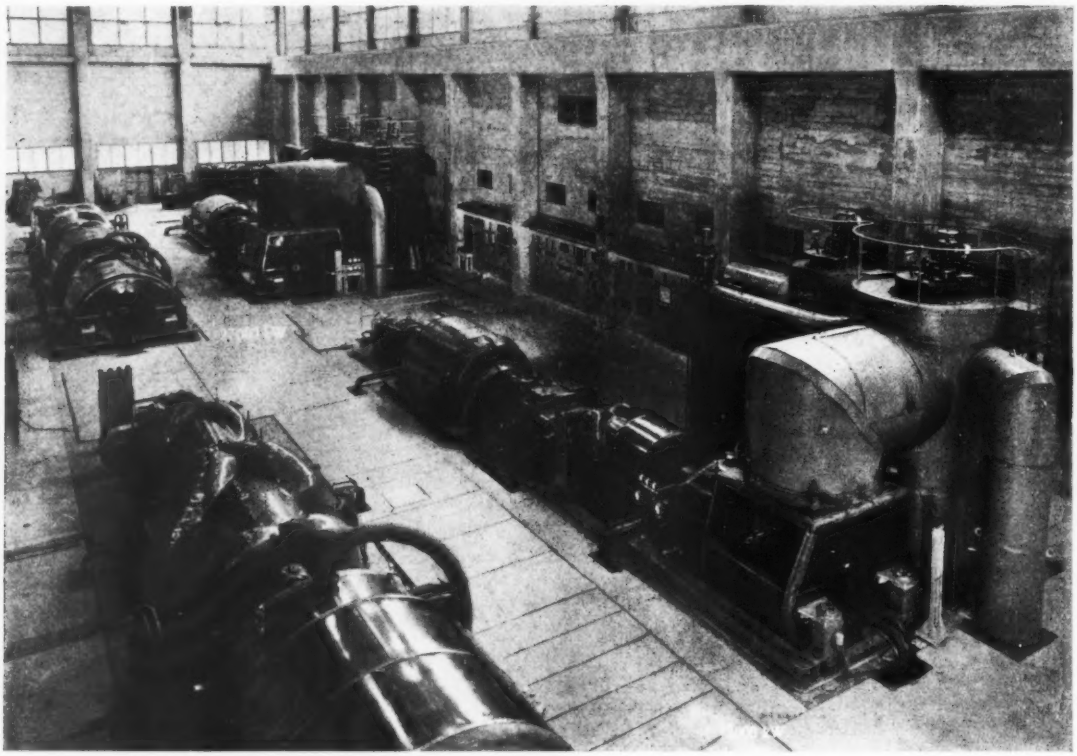


Fig. 1.—Machine Hall at Beznau Power Station, Switzerland. In front the 13,000KW Gas Turbine set, behind the 27,000 KW set.

4000 kW at 3600 rpm. Operational data are not available for full load and continuous operation, but it is claimed that running costs are low. Three BBC gas turbines are due to come into operation in Iran, and have been ordered by British Petroleum Co., Limited, (formerly Anglo-Iranian Oil Company) London, for 4000 kW each at 3,800 rpm. Fuel will be natural gas.

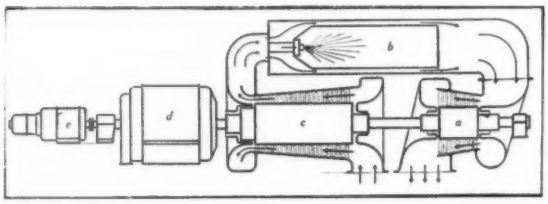


Fig. 2.—Basic design of single-shaft Brown-Boveri gas turbine (without air preheater). a, gas turbine. b, combustion chamber. c, air compression. d, alternator. e, starter motor and exciter.

In 1951 a two-stage turbine (Fig. 3) went into operation at the Electricity Works in Bukharest, Roumania, and following various reports operates intermittently ("topping") about 16 hr. per day, at an average load of 9000 kW. Natural gas from oil fields is used. Table III gives times of quick-starting operations for this set. It is claimed that up to the middle of 1953 the gas turbine started over 300 times which indicates a reliable performance.

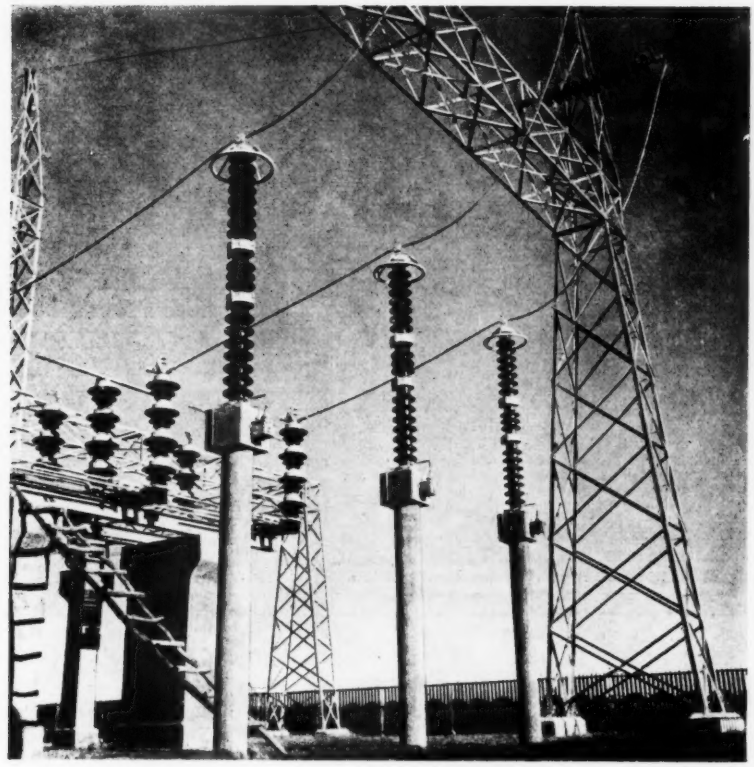
TABLE I.—Times of operation of brown-boveri gas turbine in oil refineries.

Started in year	Operational days until middle 1950	Idle periods days cause: plant	Idle periods ddys cause: gas turbine	Idle times caused by gas turbines related to total
1936	4295	50	43	1%
1939	3688	50	30½	0·8%
1939	3867	20	10	0·26%
1941	2500	169	85	3·2%
1941	3098	61	47	0·76%
1941	3084	42	24	0·76%

TABLE II.—Regulation tests on brown-boveri gas turbine in swiss power station (4000kW)

Revolutions per minute	Sudden change of load kW	Temporary variation of rotation	Average continuous variatioo
3000	0—2000	2·2%	0·85%
3000	2000—0	2·3	0·85%
3000	0—3000	5%	1·65%
3000	3000—0	4·3%	1·3%
3000	0—4000	5·0%	2·65%
3000	4000—0	5·8%	2·50%

South-American oilfields seem very suitable for simple one-stage gas turbines with heat exchangers having rather moderate capacities. Two Brown-Boveri machines of 1050 kW each supply power for



132 kV Lightning Arresters with
Discharge Counters at Bareilly.

ASEA LIGHTNING ARRESTERS

ARE DESIGNED TO OPERATE AT LOW AND ACCURATE DISCHARGE LEVELS AND THEREFORE EFFECTIVELY PROTECT ELECTRICAL EQUIPMENT AGAINST OVERVOLTAGES DUE TO LIGHTNING STROKES ON OR NEAR THE OVERHEAD TRANSMISSION LINES TO WHICH IT IS CONNECTED.

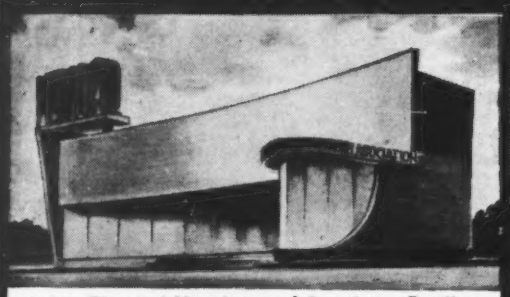
ASEA LIGHTNING ARRESTERS

COMPLY WITH AMERICAN STANDARDS A. I. E. E. 28 AND 28a AND ARE IN SERVICE IN ALL CONTINENTS AT ALL VOLTAGES UP TO THE HIGHEST IN THE WORLD.

ASEA
ELECTRIC INDIA, LIMITED

BOMBAY **CALCUTTA** **MADRAS**

Indian Industries Fair



Indian Electrical Manufacturers' Association Pavilion

Visit the Stand in this Pavilion of ASSOCIATED ELECTRICAL INDUSTRIES MANUFACTURING CO. LTD. and see a selection of the products of the Company's Calcutta Factory. A full range of Descriptive Leaflets can be obtained from the Stand.

The Largest Group engaged in the manufacture of electrical and mechanical equipment in the United Kingdom, comprising:

THE BRITISH THOMSON-HOUSTON CO. LTD.
METROPOLITAN-VICKERS ELECTRICAL CO. LTD.
METROPOLITAN-VICKERS GRS. LTD.
THE EDISON SWAN, ELECTRIC CO. LTD.
FERGUSON PAILIN LTD.
THE HOTPOINT ELECTRIC APPLIANCE CO. LTD.
NEWTON VICTOR LTD.
SUNVIC CONTROLS LTD.
BIRLEC LTD.
SIEMENS BROTHERS & CO. LTD.

A.E.I.

Represented in India by

ASSOCIATED ELECTRICAL INDUSTRIES (INDIA) LTD.

Head Office:
6 Mission Row, Calcutta

Branches at:

Bombay, New Delhi, Madras
Bangalore, Coimbatore, Nagpur

United Kingdom Pavilion

Visit the Stand in this Pavilion of ASSOCIATED ELECTRICAL INDUSTRIES (INDIA) LTD. and see a selection of electrical equipment manufactured by the A.E.I. group. Descriptive Leaflets of equipment can be obtained at the Stand.

AIX-151

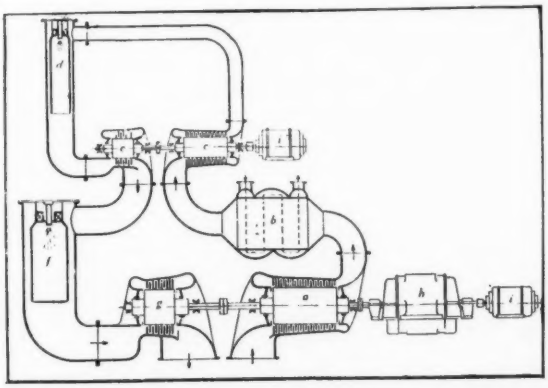


Fig. 3.—Two stage gas turbine plant for municipal electric power station at Filaret, Roumania, operating on natural gas. a, L.P. air compression. b, inter-cooler for air. c, H.P. air compression. d, H.P. combustion chamber. e, H.P. gas turbine. f, L.P. combustion chamber. g, L.P. gas turbine. h, alternator. i, starter motor.

TABLE III.—Two Gas turbine groups at 1650 kW producing electrical energy at cement foctory, pertizalete, venezuela, south America

	Group I	Total	Group II
Hours of operation up to Nar. 3, 1953..	17,502	33,725	16,223
Electrical energy produced in millions kW hr	21,423	40,723	19,300
Average load in kW	1220		1190

a cement plant (Pertizalete, Venezuela), Table III shows runnng hours and electrical energy produced up to March 1953. Fuel is a mixture of Venezuelan bunker oil (60%) and diesel oil (40%). The following are a few operational maintenance data after over $3\frac{1}{2}$ years' operation : Cleaning of ash deposits on turbine blades by means of water sprays every 700 to 900 hr. Cleaning of air preheaters during operation by integral soot blowers using compressed air. Washing of compressor blades after 3000 hr. Renewal of eroded parts of fuel nozzles after 3500 hr. Refractory elements of combustion chamber have to be renewed at the rate of 45 wall elements during 18,000 running hours. In the same plant a third 5000 kW set has been in operation since the beginning of 1953 on natural gas, and another set is due to start. These latter two machines are single-stage gas turbines without heat exchangers.

A small Brown-Boveri gas turbine unit of 1200 kW has supplied energy for refrigeration compressors in Alexandria, Egypt, since the middle of 1950, and is in operation only during the summer months. During operation in 1951 for about 2000 hr. electrical energy of 1325 millions kW was generated at an average efficiency of 16%, using a fuel oil of varying viscosity and specific weight.

Blast furnace gas is the fuel for a 5400 kW set in Luxembourg, where in 1951 a Brown-Boveri gas turbine plant as shown in Fig. 4 came into operation,

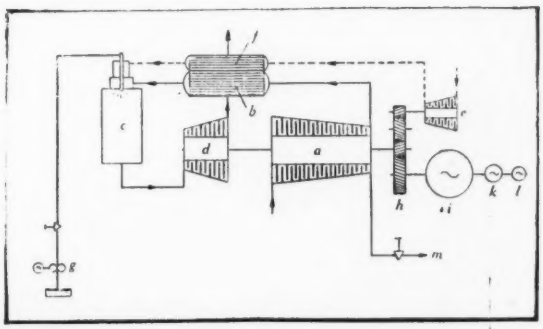


Fig. 4.—Layout of 5400 KW gas turbine plant, Dudelange. Luxembourg. a, compression. b, air preheater. c, combustion chamber. d, gas turbine. e, blast furnace gas booster. f, blast furnace gas preheater. g, fuel oil pump. h, gear box. i, alternator. k, starter motor. l, exciter. m, air pipe to steelworks.

owned by Arbed. A particular feature of this plant is that compressed air can be supplied by the compressor up to 15 kilos/second at air pressures of 3 atm. for the steelworks, and at 2.2 atm. for the blast furnaces. At the end of 1952 about 49 million kWh were achieved during 10,000 operational hours, supplying about 20% of the total energy consumption under less favourable load conditions.

Another Brown-Boveri set for the supply of compressed air from turbine-driven compressors works in Spain at the Baracaldo steelworks, using a combined burner for blast furnace gas and fuel oil, the latter in case of deficiency of blast furnace gas. Fig. 5 shows the layout and it is reported that the plant has worked satisfactorily since November 1952.

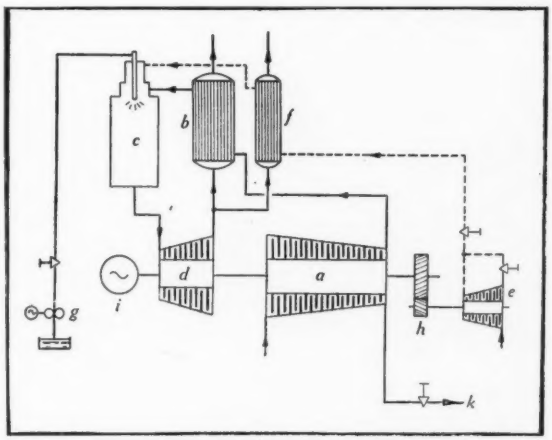


Fig. 5.—Layout of gas turbine plant at steelworks Baracaldo, Spain. A combined blast furnace gas and fuel oil burner is used. a, air compressor. b, air preheater. c, combustion chamber. d, gas turbine. e, compressor for blast furnace gas. f, preheater. g, fuel oil pump. h, gear box. i, starter motor. k, air duct to steelworks.

Of several sets in the Middle East, the electric power station at Dhahran, Saudi-Arabia, contains two 5000 kW units in operation since the beginning of 1954, and three more units will be installed. They

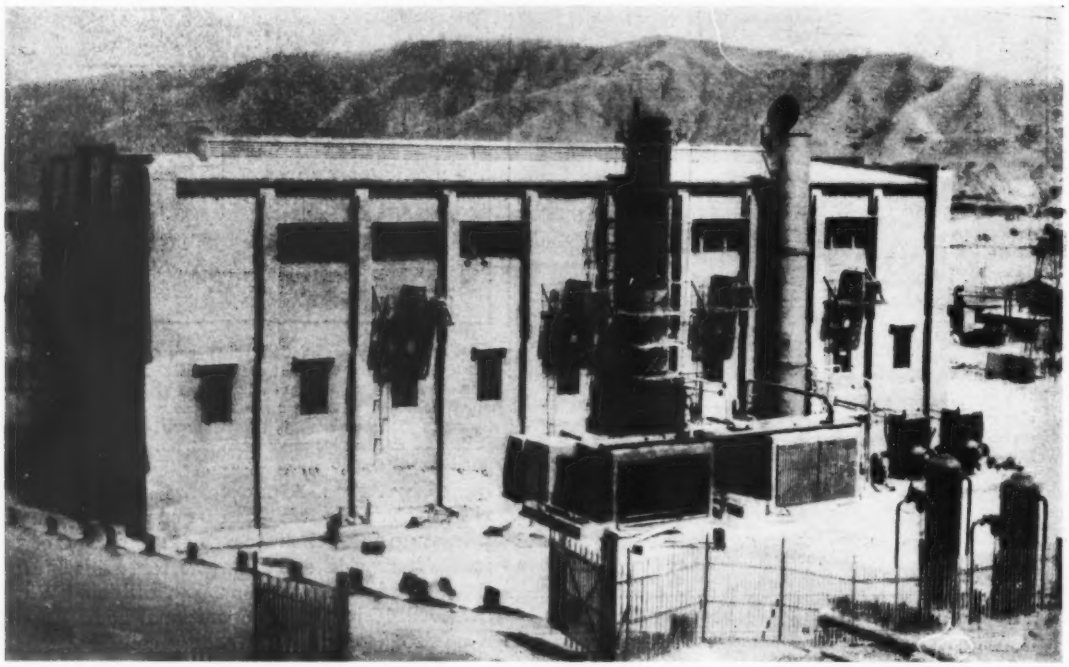


Fig.6.—Gas Turbine Power Station in Iraq Oil Refinery, previously Anglo-Iranian Oil Co.

are single-stage sets using natural gas oroil. raw Thermal efficiency is 17% at 650°C inlet gas temperature and 49°C average air temperature. A similar BBC unit and a 5750 kW unit using bunker oil will go into operation during 1955 at the electrical power station at Jeddah, Saudi-Arabia. (Fig. 6). It is known that the following factors influenced the use of gas turbines in the Middle East : Simple and robust design, reliability; ease of installation, use of less skilled plant operators, few spare parts and low maintenance costs. In addition, little spare and competitive first installation cost together with very little water consumption influenced the choice, not to forget light wieght and a low building cost.

(*Continued from page* 10)

The Engineer's Contribution to the Conservation of Natural Resources II

now with the raw techniques that have developed so so rapidly since then. By and large all are based on the application of research and their complexities breed new kinds of specialists with the dangers that involves. The remedy is a synthesis of specialists which indeed is the pattern of the combined operations which these great engineering projects inevitably demand. This, I am sure, was the thought in Graham Clark's mind in seeking a better understanding between the Institutions and of the need for their co-operation in the future.

And this survey brings out another point, the need for an ever closer working with Nature. You cannot control Nature. She will always have her way but with the more intimate understanding we are gaining of her ways a new partnership is possible with the great forces and resources that she embraces.

One final lesson emerges. In each generation there is a limit to what is possible, a limit imposed by the resources and skills that are available to mankind. In the future those resources and skills must be used to the best advantage, and with their unequal distribution among the countries of the world, some form of planning is ultimately inevitable, based on surveys of resources and world needs. Only in that way can they be conserved for the use and convenience of man.

(*By Courtesy of the Institution of Civil Engineers, London*)

Soviet Hydro-Turbine Engineering

By

N. N. KOVALEV

Chief Hydroturbine Designer, Stalin Metal works U.S.S.R.

Power being a basic requisite for the development of all industries, the Soviet Union's current fifth Five-Year Plan envisages a large rate of increase in the output of electricity-generating equipment. Thus, while overall industrial production under this plan expands by 70 per cent, the manufacture of steam turbines is to step up 130 per cent, and hydroturbines as much as 680 per cent.

This tremendous growth in the output of power-generating machinery ensures the doubling of the total capacity of all electric stations and trebling that of hydro-electric plants. The Five-Year Plan lays particular stress on the utilization of water power and the construction of hydro-electric stations. It will be noted that with its vast number of rivers suitable for the construction of such stations the Soviet Union is the world's richest country in hydropower resources.

Hydroturbine-making was first started in our country in Soviet times. In 1924, the Stalin Metal Works in Leningrad put out the first hydroturbine, a 55-kiloWatt unit. Since then it has been vigorously developing hydroturbine engineering.

It rapidly and successfully mastered the production of large hydroturbines, developed a number of its own original designs, and in 1937-1940 already put out huge 65,000-kiloWatt adjusted-blade hydroturbines 9 metres in diameter.

An important stage in Soviet hydroturbine engineering progress after the war was the creation of new hydroturbines for Europe's biggest Lenin Hydro-Electric Station on the Dnieper, which was wrecked by the Nazis during the war.

For this station, three new 78,000-kiloWatt turbines were ordered in the United States from the Newport News Company, and six from our plant. Though we built these machines while we were rehabilitating our shops which suffered greatly in the war during the siege of Leningrad, they proved to be more powerful and of higher efficiency: 93.1 per cent as against the American 92.5 per cent.

The Soviet Union is sucessfully carrying out its Five-Year Plan also in power development. New huge hydro-electric stations are being built. Several have already begun production.

Such, for example, is the Ust-Kamenogorsk Plant on the Irtysh River that uses powerful turbines supplied by our plant; it generates electricity for the Altai Territory.

The Mingechaur station on the Kura in Azerbaijan; the Tsimlyanskaya Plant on the Volga-Don Canal; the Kama Hydro-Electric Station have also been commissioned.

The turbine is the heart of an electric station. Upon its design and construction depends in what measure the power of the river's flowing water is harnessed. Accordingly, our engineers strive to design ever better turbines and incorporate in them all the latest achievements of science and technology. In our plant laboratory we test turbine models, determine the best forms for the parts of the machine through which the water runs, investigate the construction of new mechanisms. All this helps us to step up the efficiency of our machines.

Our post-war models are notably improved by the introduction of automatic controls for all processes. Preparation for starting, starting and stopping the turbines in case of any irregularity in their work, are all automatic. The controls have been further improved by the use of new extra-high precision and sensitive automatic instruments.

An important factor in the progress of Soviet large-scale hydroturbine engineering is standardization of design, to which we have given great attention in the post-war years. Owing to the specifically different conditions in which they have to work, hydroturbines, especially large ones, used to be built individually.

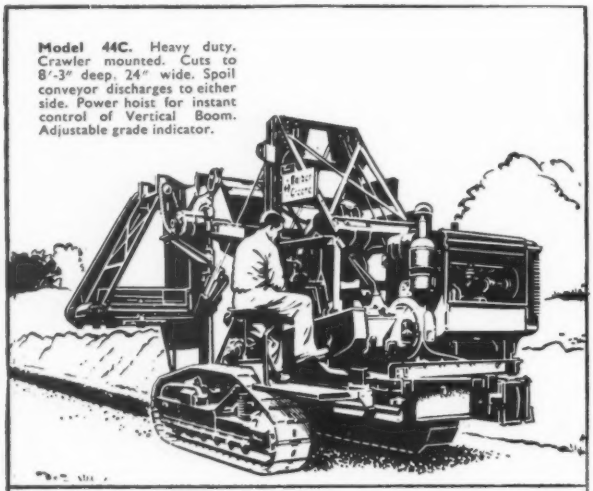
To standardize their production we have carried out extensive work in drawing up a nomenclature of types and sizes of hydroturbines ranging from 1,000 to 125,000 kiloWatt capacity.

All large hydroturbines are now designed according to uniform layouts with the use of standard sections and parts. This has greatly reduced the time of designing, preparing for manufacture, and the production of auxiliary equipment, and has helped to improve the quality of the hydroturbines.

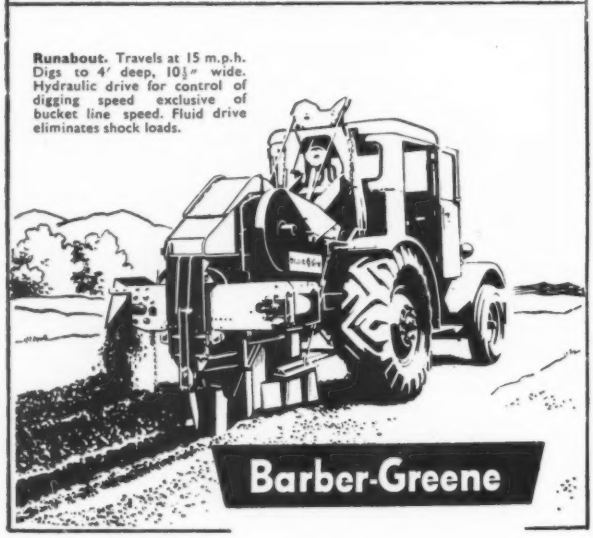
Increased capacity of individual machines has resulted in greater loads on their various parts. It therefore become necessary to make them stronger and more reliable. Accordingly, respective research in the strength and rigidity of turbine parts has been developed at our plant.

Particularly difficult problems arose before us in the construction of hydroturbines for the world's largest Kuibyshev Hydro-Electric Station which will

(*Continued on page* 24)



Model 44C. Heavy duty. Crawler mounted. Cuts to 8'-3" deep, 24" wide. Spoil conveyor discharges to either side. Power hoist for instant control of Vertical Boom. Adjustable grade indicator.



Runabout. Travels at 15 m.p.h. Digs to 4' deep, 10½" wide. Hydraulic drive for control of digging speed exclusive of bucket line speed. Fluid drive eliminates shock loads.

Ditchers

FOR LOWEST COST PER FOOT OF TRENCH

Advanced features include : the exclusive Vertical Boom that permits digging right up to walks, foundations or other obstructions, leaving no ramp . . . the milling action of closely spaced buckets that cut through coral, caliche, cemented gravel or asphalt pavement. For the complete story see your B-G Distributor.

Barber-Greene Overseas, Inc.
Barber-Greene Company, Aurora, Ill., U.S.A.

B G

Barber-Greene Olding & Co., Ltd., England
Barber-Greene Canada, Ltd., Canada

"Ask Jacks about it"

William Jacks & Co. Ltd.

CALCUTTA BOMBAY MADRAS

Sole Agents for

Barber-Greene Overseas, Inc. Aurora, Illinois, U.S.A.
Barber-Greene Olding & Co. Ltd. Hatfield, Herts, England.

No. 1058—D.

Coal Industry Symposium

Issue of

INDIAN MINING JOURNAL

Carrying altogether 45 papers by leading authorities, read at the symposium on India's Coal Industry organised jointly by the Geological, Mining and Metallurgical Society of India and Indian Mining Journal.

Price: Rs. 7/8/-

Place your orders with:

The Manager,
INDIAN MINING JOURNAL,
6/2 Madan Street,
Calcutta-13.
Phone : 23-1765

Our Delhi Letter

(From our Special Correspondent)

Concrete Placing Ceremony, Bhakra Dam

The big event of the month was the historic gathering at the Bhakra Dam site where Pandit Jawahar Lal Nehru inaugurated the placing of conrete by pressing buttons which started off the giant mixing plant. Thousands of workers and officials and publicmen watched the ceremony. Pandit Nehru said he was inspired by the river and the hills which had been there since geological ages. Now for the first time man was engaged in harnessing these mighty forces into the service of the region. In this process, he was playing a role far bigger than himself. He derived some greatness from the mighty elements which he was going to subdue.

All workers as the great "Unknown Soldiers"

But in such gigantic undertakings, one cannot pick out a few names and give them credit. The association of the humblest workers is equally important. Many of them have lost their limbs and lives in the performance of their duties. They are martyrs representing "the great unknown soldiers for this peaceful war against famine and unemployment". Let a memorial be erected in the memory of all such people. The great Project when completed will be the offering of the workers to the nation.

Team spirit praised

Earlier, the team spirit exhibited by the various important wings of the administration, consisting of Design, Construction and Inspection, was appreciated by the General Manager, Shri S. D. Khungar and the Irrigation and Power Minister, Chaudhari Lahiri Singh. "It is the cooperation of all workers that is essential for the success of the Project and such cooperation has been forthcoming in full measure from the nationals of various countries who are associated in the Bhakra Project. Indian Engineers are taking full responsibility for the various phases of the Project in which foreign experts are engaged in a consultative role."

Construction Schedule of Bhakra Dam

Just as in the case of the Industries Fair, unprecendented rain had caused a lot of dislocation in the access facilities to the dam. There were enormous slips in the hills and the footings of many of the trestles of the belt-conveyor system had yielded. The two most difficult sections had to be realigned and reconstructed by improvised arrangements in order to remain true to the target of the concrete placing ceremony for which 17th November had been fixed as the date when the Prime Minister of India was to place the first bucket of concrete. It was, indicative of the strong will of the Indian people that there should be no sliding in the dates even in the face of tough hurdles that Nature's fury had placed in the race-track.

Money Schedule as important

Of late there has been a clamour about misuse and misappropriation of public funds in the Bhakra Canals Administration. Certain cases are now under investigation. The public, however, need a discriminating and an impartial eye in order not be mis-led by slogans or suspicions which can be nothing more than distrust or magnifying out of proportion to the guilt or default. The punishment of the guilty individuals must on no account be condoned but it would clearly be wrong if unbalanced propaganda is allowed to soil the reputation of the big undertaking for which so many honest workers are toiling with their sincere endeavours. On the Bhakra Dam itself, the agency of construction is almost entirely departmental and work is paid for on the pay-roll. Wise and economical planning and designing, coupled with efficient execution under a vigilant supervision are the keynote of the work. The result is therefore almost insured to be appropriate. But the public mind is needed to be correctly educated so that by any undue suspicion or interference they do not detract the workers from their main tasks. It is, however, of the utmost importance that the management remain like an open book and any details required can be furnished for the asking to any responsible section of inquiry. The administrators, financiers and engineers must have joint responsibility, no one section should handicap the other from the due and timely discharge of their functions. Most troubles arise when these sections start pul ing asunder in stead of in one direction.

26th Meeting of Central Board of Irrigation

In New Delhi, this months important event was the annual meeting of the Central Board of Irrigation which is still the most representative forum of the Irrigation and Power Engineers and Research workers of the Centre and all the States. Here the principle of democracy and the cooperative and coordinated endeavour that underlies the constitution shows itself in high class traditions which have been evolved over a quarter of a century. But, as in all democratic institutions, a continuous drive is needed to emanate from the participants, to prevent stagnation and foster activity and energy without which progress is quite impossible.

C.B.I versus C.W.P.C.

The chairman Shri Des Raj Metha (Chief Engineer, Bihar) made some frank and cogent observations in his Presidential address regarding the necessity of certain organisational improvements and readjustments for the healthy and dynamic working of the Board. He was indirectly critical of the "usurpation",

as it were, of some of the Board's functions by the C.W.P.C. and consequent loss of importance and dignity of the Board. His specific suggestions, given below, are all of a constructive nature and they deserve the consideration of the profession as well as of the Central and State Governments.

(1) The administrative control of the Information Bureau and Library should remain with Secretary C.B.I. instead of an Officer of the C.W.P.C.

(2) The Seminars which are now convened concurrently with the C.B.I. Research Committee meetings should be held under the auspices of the C.B.I. and not the C.W.P.C. as their functions are properly covered by the charter of the C.B.I.

(3) The Board itself should be considered as the coordinating body of Chief Engineers and no separate technical body need be constituted. The Board should make its recommendations to the Coordinating Committee of Ministers.

(4) Any important problems or subjects of technical interest concerning River Valley Project should be discussed through symposia convened by the Board. There is a lot of duplication in the present arrangement and the utility of the Board has been badly jeopardized.

Whereas the points raised by the Chairman are indisputable, one cannot but ask the Board to look into their own affairs. A period of stagnation has unfortunately been the keynote of the Board's history ever since the memorable International Engineering Conferences held in January 1951. Inspite of the fact that the tempo of engineering endeavour in the field of Irrigation and Power has been rising to a high pitch since 1951, the Board has made no effective efforts to equip itself with commensurate resources in personnel or other technical facilities to keep pace with the times. The office of the Board is extremely inadequately staffed. The post of Secretaryship should either have been brought cent per cent under the C.W.P.C. organization or else it should have been strengthened a dozen fold to enable it to cope with its proper functions.

The Remedy

It is conceded on all scores, therefore, that the democratic nature of the Board needs to be preserved. It will be a retrograde step to convert it into a department or subdepartment of C.W.P.C. But fresh blood must be infused into this organism so that it can grow into a sturdier institution in the present stress and strain of a fastly developing economy. The post of Secretary needs to be upgraded to at least a Chief Engineer's or a Member's status to enable its incumbent to discharge its functions. And most important, he needs to be assisted by a team of three or four mature but active engineers and Research Officers to cope with the volume of work which needs to be sifted and written up for being presented and discussed in the large and representative gatherings which are convened twice a year by the Board. Needless to say, the success of such an expansion will depend on the choice of the individuals for these positions—the men put in charge of the manning of this vessel should be outstanding and their service history and experience should leave no doubt as to their capacity to succeed.

Sri V. T's address

It was a treat to listen to old Sri V. T. discoursing on his pet subject of planning with particular reference to Irrigation and Power Projects in the country. He explained that the size of the First and the Second Plans was stependous when measured by the yardstick of the past but still insufficient when seen in the perspective of our needs. We have multiplied our irrigated area and also put a much greater portion of it under secure irrigation from dams and canals. The development of techniques has given us the means to go ahead with high dams and reservoirs, but the cost of such projects is high due to the very nature of the constructions. As such the cost per irrigated acre is bound to be much higher than the earlier diversion weir projects. Hence the necessity of finding some sources of financing these new Projects assumes a different role altogether.

In the case of countries like the U.S.A. the principal profession of 70% to 80% of the people is industry and trade. For self-sufficiency they have to produce enough food, and the requisite land and water resources are harnessed by them at whatever it may cost. The benefits from their multipurpose projects are reflected in their great industrial achievements. Since agriculture is not the most lucrative profession, it has to be subsidized by the other industries who attain a high enough price level for agricultural produce to keep up the incentve for the 20% to 30% of the people employed in this work. Such a situation is clearly not possible for India, where the large majority of people subsist on agriculture. Hence there are the following essential requisites for the development of India's River Valley Projects :—

(1) The financing of the River Valley Projects has to be supported by a betterment levy to be recovered from the areas benefitted due to the introduction of Irrigation and Power facilities which help to develop the region to a higher potential.

(2) The people who are benefitted should willingly and cheerfully accept the burden of contributing to such finances.

(3) The utmost efficiency and economy should be achieved in the planning, designing and execution of such projects.

(4) The State should support and implement any organisational improvements which the engineers consider necessary for the successful working of their departments and institutions. The creation of the All-India service of Engineers in an integrated scheme

(*Continued on page* 22)

Notes & News

Heavy Electrical Equipment Factory in India
AEI to establish

A 15-year agreement was signed today between the Government of India and a British firm, the Associated Electrical Industry Ltd. to establish a factory to manufacture heavy electrical equipment.

Expected to commence production in five years, the factory will produce electric generators, transformers, turbines for hydro-electric projects, railway traction equipment and similar specialized equipment which will be increasingly required with progressive industrialization.

The factory will take seven years to develop to full capacity.

A team of engineers selected by the British firm, who will act as technical consultants, is to arrive in India by the end of this month to recommend the best location for the factory. Indian experts will be associated with the team.

The location is expected to be selected within four months, and the A.E.I. is to submit a detailed project report within a year. The A.E.I. is to associate Indians with all stages of the project work in India and the U.K. to make maximum use of engineering and other industries in India and to train Indian personnel.

The agreement gives the Government the right to select for manufacture any of the equipment manufactured by the A.E.I. group which falls within the category noted in it, and to the latest manufacturing methods and processes.

According to a Press Note, the terms offered by the A.E.I. were considered the most favourable out of a number of offers made. The A.E.I. consists of a group of a dozen leading British manufacturers and their subsidiaries.

* * *

"Anomalies" to be removed

The Irrigation and Power Minister, Mr. Nanda, introduced in the Lok Sabha the Electricity (Supply) Amendment Bill seeking to remove the "anomalies and difficulties" which had come to notice in the working of the original Act of 1948.

The statement of objects of the Bill said that the proposed amendments had been under prolonged deliberation and were largely the result of decisions taken at the inter-State conference held last February. At this conference representatives of the electricty supply industry were also heard.

The Bill proposes to empower the State Governments to exercise control over the activities of the boards in matters of policy and to require the boards to consult the State Governments in the preparation of schemes estimated to cost over Rs. 10 lakhs. It is also proposed to subject to the approval of the State Governments the directions that might be given by the boards to local authority licencees in connexion with their amortization and tariff policies.

It is also proposed to link the standard rate of reasonable return for electricity supply licensees with the Reserve Bank rate at 2% above the latter to enable its automatic adjustment with the money market. When the principal Act was passed, it is explained, the Reserve Bank rate was $3\frac{1}{3}$% and the standard rate was fixed at 5%, that is, 2% over Bank Rate. Bank Rate rose to $3\frac{1}{8}$% in 1951 and, therefore, an increase in the standard rate by $\frac{1}{2}$% was justified.

The Bill also seeks to "close loopholes" by which licencees were able to earn a return in excess of that intended under the Act.

Limit on Dividends

It is further proposed to prevent licencees from paying dividends on share capital in excess of 3% or from distributing other profits so long as any arrears of depreciation or previous losses remained to be written off in their books. Also, it is proposed to require them to reduce their rates when their clear profits exceeded the amount of "reasonable return" by 15%, as against the existing limit of 30%.

The Bill also proposes to enable the electricity supply industry to avail itself of the benefits of the development rebate permitted under the provisions of the Finance Act, 1955, by allowing the creation of a development reserve. The accumulations in this reserve would be utilized for the development of the undertakings. Licencees, however, are not to be permitted to earn a "reasonable return" on assets financed from this reserve.

Under the existing provisions of the Act, the interest-free loans granted to the boards by the State Governments are repayable out of their revenues. To reduce the financial liabilities of the boards, such loans are proposed to be treated on the same footing as interest-bearing loans advanced by the State Governments and they would not be repayable out of the revenues of the boards. With the same object, provision is proposed to be made to enable the boards to repay the loans borrowed from sources other than the State Government out of the accumulations in the depreciation reserve instead of their revenues.

The Bill seeks to tighten control over the financial operations of the boards. It proposes to achieve this end by subjecting their accounts to the audit of the Comptroller and Auditor-General of India.

* * *

Secret Race for Cheap Electricity

British, American, German and Soviet scientists are engaged in a secret race to produce cheap electricity through "cold combustion" of fuels, Professor Eduard Justi said in Brunswick (West Germany).

The research was being carried out in even greater secrecy than the research into atomic energy.

Professor Justi who is Director of the Brunswick Technical University's Institute for Applied Physics, recently demonstrated his "cold combustion" theory before an audience of several hundred scientists and political and cultural leaders at Mainz (West Germany) on Oct. 28. He produced an electric current by combining oxygen and hydrogen in a "fuel element."

Professor Justi told the audience at the demonstration that the "fuel element," which operated without igniting the fuels, had an efficiency ratio of 70%, compared with the 40% efficiency ratio of the internal combustion engine.

* * *

Canada to help India in Rural Electrification

A new Canadian contribution to India under the Colombo Plan, announced by Mr. Lester Pearson, will greatly help to accelerate the pace of rural electrification. It is a $3-million project to supply diesel generating sets to Indian villages.

Another new project to be carried out by a Canadian company is an aerial magnetometer survey for mineral resources, particularly petroleum in Rajasthan. A third is the gift of two Canadian aircraft for aerial spraying of insecticides.

The Canadian Secretary of State for External Affairs also announced that his Government had decided to contribute $100,000 to India and Pakistan for flood relief in the form of drugs, medical supplies and emergency materials.

Work on installing an atomic research reactor on the model of the Chalk River reactor in Ontario would begin early next year. While it was being constructed, Indian scientists would be trained to operate it in Ontario.

* * *

India assists Nepal's Irrigation Projects

A network of irrigation projects intended to bring more than 30,000 extra acres under irrigation is now under way in Nepal. This task, it is officially stated, was undertaken by India as part fulfilment of her obligations to Nepal under the Colombo Plan to execute a number of projects of far-reaching economic and social significance to that country.

These Projects include not only the development of communications in Nepal but provision of increased facilities for irrigation and the improvement of drinking water sources.

Ever since the Governments of India and Nepal formally signed an agreement exactly a year ago, surveys have been carried out for a number of projects and some of them have actually been sanctioned for execution. According to the agreement India undertook to provide aid valued at Rs. 50 lakhs over a period of four years to be spent on irrigation projects and the improvement of drinking water facilities. The services of engineering and technical personnel, who were to assist the Public Works Department of the Nepal Government, were also to be lent by India.

In Kathmandu valley work on two irrigation projects—one at Mahadev Khola and the other at Tikka Bhairav—has begun. When ready these projects will have cost Rs. 3.5 lakhs (in Indian currency) and will add about 200,000 maunds of paddy to the supply of food in that region. The construction of the projects is in progress.

In the Pokhara valley, which is not self-sufficient in food, the upper and lower Vijayapur projects will irrigate large tracts of land including some 1,600 acres not at present cultivated for want of irrigation. In consequence, paddy production is expected to rise by about 135,000 maunds. The cost of these projects —which are likely to be completed by May 1956—has been estimated at Rs. 10.5 lakhs (Nepalese currency).

Furthermore, the preliminary survey of two more irrigation projects in the Rautahat district of the Terai has been completed. Simultaneously, another project for the clearance of the bed of the Jhaj river has been undertaken.

The six irrigation projects, including the two at present contemplated, will bring 31,000 extra acres under irrigation—8,000 in the Kathmandu valley, 9,000 in the Pokhara valley and 14,000 in the Rautahat district. If a reasonable charge can be levied for irrigation facilities provided by the Government, the capital invested will yield a fair return. The question of levying such a charge and of finding a portion of the proceeds for the purpose of extending irrigation facilities on a large scale in the different parts of the country is being considered by the Government of Nepal.

* * *

Negligence in Maintenance and Repairs of Bunds

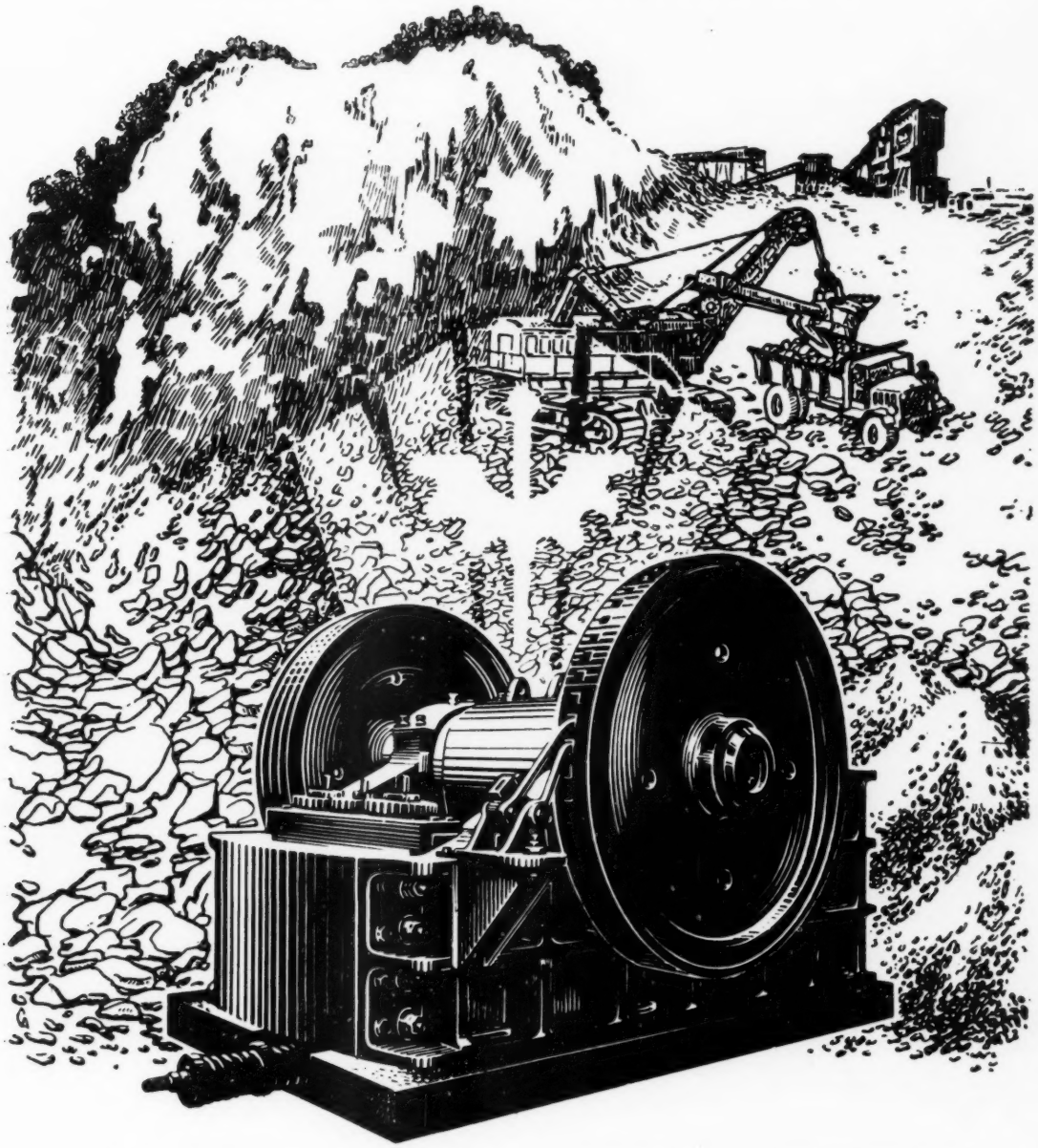
The three-man official committee which inquired into the breaches in the Lal Diggi bund on the river Tons near Azamgarh and the Moloney bund on the Rapti river near Gorakhpur, U.P. has submitted its report to the U.P. Government.

The committee, has found that there had been negligence in the maintenance and repair of these bunds by the Public Works Department officials.

The maintenance of these bunds, it is expected, will be transferred to the newly created flood division of the Irrigation Department as a result of the findings of this committee.

(*Continued on page 22*)

Visit the Hungarian Pavilion at the Indian Industries Fair in New Delhi



Machinery for grinding, sizing, classification, flotation, filtration and many other uses in ore dressing mills, road building, etc.

Exported by :

NIKEX Hungarian Trading Company for Products of Heavy Industry

Budapest 4 P.O.B. 103 Hungary Cable Address : NIKEXPORT

Power for prosperity in India via HENLEY *transmission lines*

In Andhra State between Gooty and Cuddapah–Henley's are at present erecting for the Andhra State Electricity Department 98 miles of 66 KV Double Circuit Tower Line in connection with the Tungabhadra Hydro Electric Scheme.

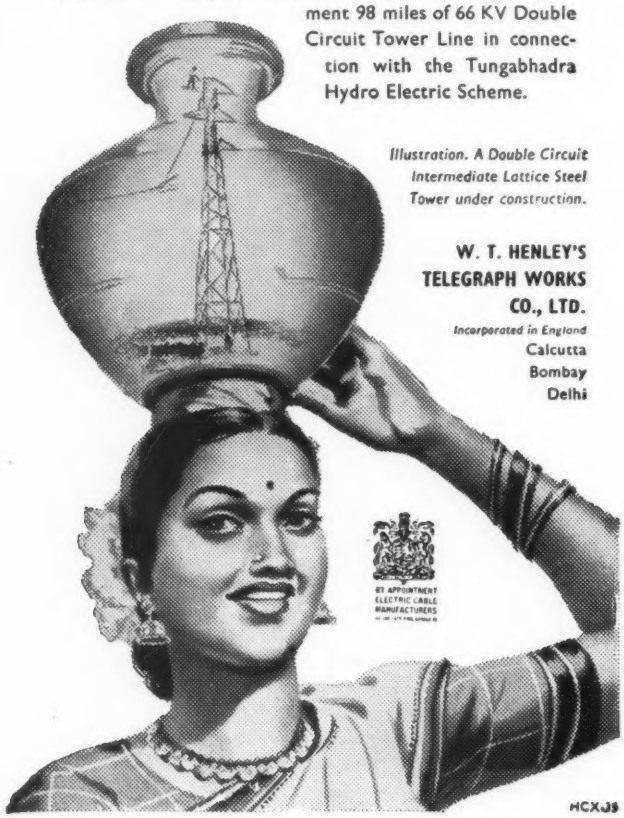


Illustration. A Double Circuit Intermediate Lattice Steel Tower under construction.

W. T. HENLEY'S TELEGRAPH WORKS CO., LTD.
Incorporated in England
Calcutta
Bombay
Delhi

HCXJ9

Editorial

Electrification and Small-scale Industries

The Report of the Village and Small Scale Industries Committee, of which Prof. D. G. Karve was the Chairman, has been recently published. For the first time it gives a clearer picture of the proposed pattern of development of the village and small scale industries in India and its organic relation with the total economy of the country. In its absence there has been much confused idealism and a general spirit of condemnation of the machine-age as such. The Committee very clearly states. "It may be noted at this point that as regards the need for technical improvement of existing equipment or of adopting the most improved technique possible in the existing structure there is no difference of opinion." (p. 18).

The Committee visualises a decentralised pattern of society where the centres of industrial productive activity are spread out in the numerous large villages and small towns, and not concentrated in big cities like Bombay or Calcutta. In the opinion of the Committee decentralisation means "adopting improvements in technique in such a manner and to such an extent that economic activity is still possible and in comparatively small units widely scattered or dispersed throughout the country." (p. 19).

Starting from this perspective as to the pattern of development, the Committee lays great emphasis on the proper use of large quantities of electricity being generated or planned to be generated in the immediate future. The Committee has therefore been critical of the present policies regarding electrification. It says :

"Both the physical and the economic aspects of a decentralised, yet progressive, economy are vitally dependent on the availability of cheap power in rural and semi-urban areas. Large schemes of hydro-electric and thermal generation of electricity have been included in the first and second five-year plans. There is, however, a tendency to look upon the financial results of each system in isolation. From a state of having no plan as regards utilization, to making hurried contracts with bulk purchases of energy, all manner of variations in policy have been known to exist. As a rule electricity tariffs are such as favour the large consumer in preference to small consumer, and the urban consumer in comparison with the rural one. While some reservation of energy for rural uses is being planned and some concessional rates given, there is as yet no revision of the whole policy of the generation, distribution and sale of electrical energy in conformity with the accepted policy of decentralisation.

"Once this policy is firmly adopted in the plan, along with a grid for energy, there should be a pooling of costs and returns as well. In some States, the most advantageous areas from the point of view of returns are at present the preserve of private licensees. It is necessary to ensure that the operation of private licensees conform in this respect to the requirements of national policy.

"One of the most important factors in transforming Indian economy into a progressive yet decentralised and co-operative structure is the spread and use of electric power all over the country. The cost of rural electrification may, therefore, be appropriately counted as part of the general costs of improvement of the economy as a whole. Wherever an electrification scheme is likely to take long before it begins to pay its way, as is likely to be the case with several schemes of rural electrification, it should be the policy to charge a large part of its initial investment e.g. installations and distribution lines to the development budget of the State. Equally any deficit in working cost incurred during the initial years as a result of a tariff structure which is framed so as to make power available to the small consumer at reasonable rates should be treated on the same lines." (p. 23).

We have of course in the past laid stress on rural electrification. We, therefore, welcome the Committee's stress on this aspect. We however, refrain from discussing here the Committee's viewpoint regarding decentralised industry vis-a-vis a centralised industry, as this is not the proper place to do so. But we express our wholehearted support to the idea of a dispersed pattern of industrial centres in our numerous towns and villages, and the river valley schemes on a basin-wise scale would greatly accelerate this development. But for this cheap river transport and cheap power on a wider sector need to be greatly stressed.

(*Continued from page* 20)

Notes and News

The two bunds were constructed about fifty years ago as flood protection measures. The breach in these bunds due to floods in July caused wide-spread damage. Low-lying parts of the Azamgarh town were flooded and a large number of houses collapsed, when the water of the Tons entered the town on July 27 through a breach in the Lal Diggi bund.

The breach in the Moloney bund on July 30 marooned about 150 villages in the districts of Gorakhpur and Deoria and laid waste thousands of acres of cultivated land.

The inquiry committee consisted of Mr. Govind Narain, then Secretary of the Public Works Department and now Development Commissioner, U.P. (chairman), Mr. A. N. Khosla, vice-chancellor, Roorkee University, and Mr. M. S. Bisht, chief engineer, P.W.D.

* * *

Indo-Pakistan Talks on Flood Control end in success

The Indo-Pakistan talks on the possible joint flood control measures in the eastern region of the subcontinent concluded at Karachi with the two delegations promising each other the fullest cooperation.

The two delegations also agreed that another meeting at ministerial level should be held soon.

During the talks, the Indian team led by Mr Kanwar Sain explained with the aid of maps the functioning of various flood control organisations now in operation in India. The Indian team also promised to supply all hydrological and meteorological data useful for forecasting floods in East Pakistan as also for devising ways and means of controlling them.

It is understood that the Pakistan team led by Mr. Mohsin Ali, consultant to the Pakistan Planning Board, promised full support in any joint endeavours and asked for professional aid of the Indian engineers in tackling the flood problem.

The Indian team assured the Pakistan team that the Indian Prime Minister, Pandit Nehru, wished "the utmost co-operation between the two countries on flood control measures and exchange of technical information".

* * *

Meeting on Ministerial level likely to finalise Plans

An Indo-Pakistan meeting on ministerial level is likely to he held shortly to finalise plans for joint flood control measures to be undertaken by the two countries.

Mr. Gulzarilal Nanda, India's Planning Minister told that joint measures, the undertaking of which had been agreed to on principle, included flood warning and flood forecasting system and the setting up of rain gauges.

This would help in finding out as to how much rain had fallen in the catchment areas. By doing so they could make necessary arrangements in advance to protect people living in areas likely to be affected by floods.

Mr. Hamidul Huq Choudhury, Pakistan Foreign Minister, told in Dacca that funds for these joint measures might be available from the Colombo Plan.

Mr. Choudhury, who had just returned from the consultative conference of the Colombo Plan in Singapore, said that the conference had accepted the principle that flood control which affected two of the plan countries was a fit subject for close study by the organisation and its assistance.

Mr. Huq Choudhury said he would have further talks on the subject with Mr. Gulzarilal Nanda to give concrete shape to proposals they had discussed at Singapore.

India, Mr. Nanda said at Ahmedabad, was in a better position to help Pakistan in respect of flood control measures. "We have assured Pakistan that we will give them every help and co-operation in this matter", he said.

The Planning Minister added that India had already made such arrangements, with Nepal and Tibet. Those countries had agreed to set up rain gauges and to give timely warning of the coming floods.

He said India had also set up a network of wireless sets for the purpose and more sets would be installed soon.

(*Continued from page* 18)

Our Delhi Letter

is one such step which should receive the attention of the Government without delay.

Concrete vs Masonry for Dams

The C.B.I. session concluded with a symposium on this well known "controversy". The points that emerged after an able exposition by Messrs Champhekar, Mitra, Char, Handa and others of the pros and cons led to the unanimous feeling that this subject was hardly one which should arouse any sentimental pronouncements. It should be adjudged on the touchstone of design and economic considerations in the context of up-to-date scientific techniques. As such it should be left to each chief engineer leading the project to go into and establish the superiority or otherwise of the form of construction that he recommends to be selected. It needs however to be remembered that there can be a good and bad standard both as to quality and costs in both types and it is only further research and actual progressive experimentation that will decide the issue in each case. Masonry should also evolve the same type of tests and controls which have "nourished" concrete into its present pedestal of certainty and confidence.

Book Review

Big Dam Foolishness by E. T. Peterson, published by Devin-Adair Company, 23, East 26th Street, New York-10, N.Y. pp., 224, price $ 3.50.

A book with the above title has been recently published in America. It is a challenging book indeed. Every engineer, administrator or legislator, in fact every citizen who is interested in flood control in particular and resource conservation in general, should go through it whether one agrees with its arguments and conclusions or not. India has taken to river valley development on a pretty large scale and dam construction is one of the prominent items in its development plans. This is not only true for India but also for other Asiatic countries like China, Burma, Indonesia, Ceylon, Afghanistan, etc. Flood control is one of the major and chronic problems of the region. This book declares that big dams are no way to flood control, they only accentuate the problem and create many more. It suggests an alternative and a more basic approach to the problem. Although its analysis of the issue is based on American experience and data, it is possible that there may be a kernel of truth in its approach that may hold good for other regions as well. Asiatic regions have at least one advantage over the Western countries, namely, that they can get the benefit of experience of the Western countries before adopting the latter's methods in modernising themselves. Slavish imitation of the West would be shortsighted. It is from this point of view that this provocative book is recommended.

The author argues against the big-dam program, especially as it applies to prairie plowlands. He maintains that large dams provide smaller impoundment capacity to hold run off than the aggregate of small detention reservoirs ; the former also cost more than the latter for an equivalent storage capacity. The large dams start a process of backwater sedimentation which, in many cases, spread indefinitely upstream and into tributaries. It provides virtually no means to raise the general watertable by recharge. Its reservoirs promote evaporation of water in contrast to ground storage which eliminates evaporation. And there are other arguments, including political.

The author strongly argues for the method of "insoak" which means a policy of trying to hold the water where it falls.

While it may appear from the book that the author is involved in a partisan warfare between two departments in the United States, the larger issue involved lies in the understanding that we are face to face with two alternative and mutually exclusive lines of development, and before we proceed very much farther, we should boldly face the issue. It is this bold and challenging posing of the problem that merits our immediate attention.

Industrial Power Systems Handbook edited by Donald Beeman published by McGraw-Hill Book Company Inc., 330 West 42nd Street, New York 36 N.Y. pp. 971 price $ 12.50.

The engineering knowledge required to maintain and operate industrial power generation, transmission, and distribution systems has increased manyfold since electricity was first used in industrial plants to light a few lamps and run a line shaft motor. The exacting power requirements of modern production equipment necessitate the introduction of refinements in power system design as to voltage spreads, service continuity, flexibility, etc. Since the introduction of the load-center power distribution system, industrial practices have been almost completely revolutionized.

This book outlines up-to-date industrial power system engineering practices which should be especially valuable to industrial plant engineers and electricians, utility power salesmen, consulting engineers, contractors, industrial power application engineers, architects, and others who have anything to do with the planning of electrical facilities for industrial plants or commercial buildings. College professors and students should find use for it where it is desired to teach and study the principles of industrial power system engineering.

Many of the application data have been presented in condensed tabular and curve form to make practical solution of many problems easy and fast. Numerous examples are included illustrating the use of the principles and data outlined in this book.

The general order of chapters is that the technical information is placed in the first part of the book and the economic or system design information in the latter part of the book.

The chapter headings are : Short-circuit-current Calculating Procedures ; Symmetrical Components as applied to Short-circuit-current Calculation on Three-phase Systems ; Selection of A-C Short-circuit Protective Devices and Circuit Equipment ; Voltage—Standard Ratings, Allowable Variations, Reduction of Variations, Calculation of Drops ; System Overvoltages—Causes and Protective Measures ; System Grounding ; Equipment Grounding ; Power-factor Improvement ; System Overcurrent Protection ; Selection of System Voltages ; Load center Power Systems and Circit Arrangements ; Secondary Distribution Systems; Primary Distribution Systems ; Power Systems for Commercial Buildings ; Modernization and Expansion of Existing Power Systems ; Steam and Power Generation ; Load and Cost-estimating Data.

As all the 14 authors belong to the General Electric Company, U.S.A., it is natural that they mostly though

not always referred to their experience in that Company. This handbook would be immensely useful to our growing number of electrical engineers as the power projects in this country as well as in South East Asia obtain a high priority in development plans.

The get up of the book is, as usual, excellent. The book is replete with illustrations.

Principles of Electronics : by E. T. Agger, B.E., published by Macmillan & Co. Ltd., St. Martins Street, London, pp. 340 price 18 shillings.

This is a text book on the subject of Electronics for use by the electrical student for whom the subject is increasingly becoming important. The book deals only with the principles and basic applications of the subject. Typical examination questions as well as revision exercises are also given at the end of the book. The subject has been dealt with ably and the volume should prove valuable to the students concerned.

(Continued from page 15)

Soviet Hydro-Turbine Engineering

have a capacity of 2,100,000 kilowatts. The most economical adjustable-blade turbines yielding high efficiency under various loads have been selected for this station.

An idea of such a turbine, which will be the largest in the world, may be had from the following. Seven hundred cubic metres of water under a pressure of 20 to 30 metres will run through it per second. Its capacity will reach 126,000 kiloWatts. Its ring is 14 metres is diametre. The runner with the adjustable blades has a diametre of 9.3 metres, and resembles a steamship propeller placed vertically. A shaft connects the runner with the rotor of the generator. Flowing over the runner the water will rotate it and with it the rotor of the generator which will produce electricity. Together with the generator the turbine reaches 40 metres in height, or that of a 10-storey building, and weighs more than 3,000 tons.

The immense size and enormous capacity of the turbine caused difficulties in designing it, as the load on its various parts greatly increased and their rigidity lessened. Besides being strong the parts must be shaped for the effective flow of the water, the channels must be wide. An increase of the channels, however, would have required to make the power-house wider and that would have raised the cost of construction. To obtain the most suitable form with the smallest possible dimensions we carried out many investigations on models in our plant laboratory.

The personnel of our plant have successfully solved the complex problems that confronted them in creating powerful hydroturbines. We have already built 9 turbines for the Kuibyshev Hydropower Station. They are now being installed, and some of them will begin operation this year.

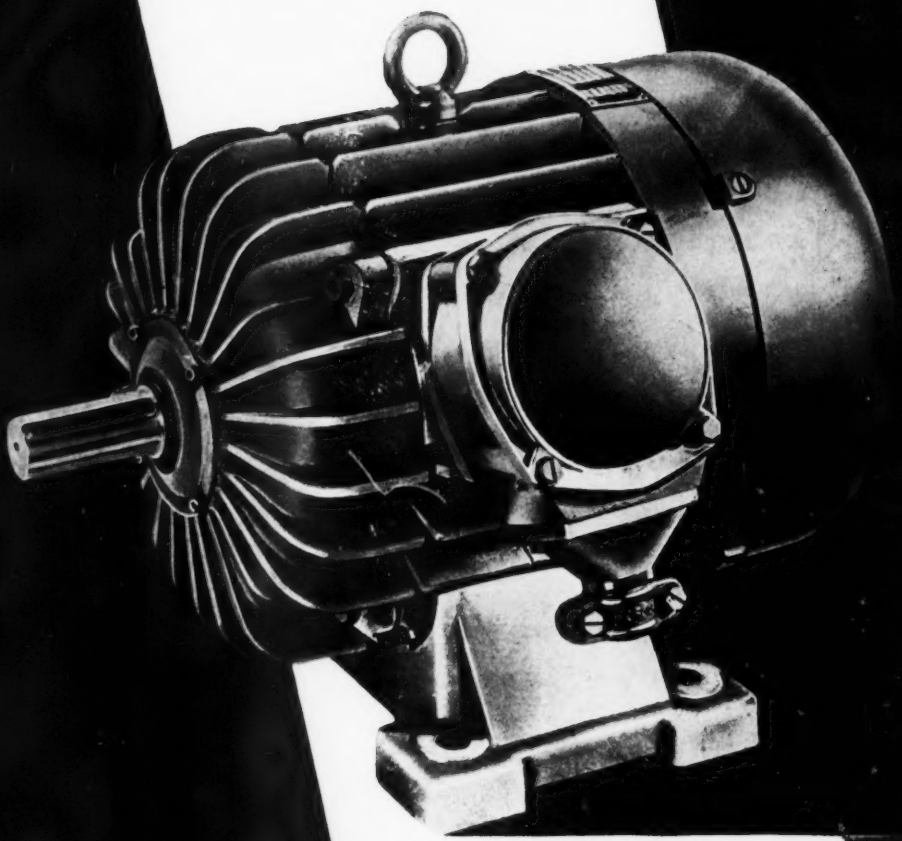
Now our engineers are designing still more powerful turbines with capacities 2 to 3 times greater than that of the existing ones. And this increased capacity must be compressed in practically the same dimensions as existing turbines, which is conditioned by the size of their parts, their machining, and railway transportation. Consequently, a much greater load devolves on the parts of such super-powerful hydroturbines. Therefore in addition to the usual complex work on creating the flow part of turbines, it now becomes necessary to carry out a particularly large amount of no less complex and responsible work to ensure the required strength and reliability of these super-powerful turbines (its rotor particularly).

For the solution of specific problems we set up integrated teams including scientists, engineers, and worker innovators in production. The blueprints of these turbines are widely discussed not only by the plant's Technical Council but also by broad technical conferences at shop designing bureaus. This makes it possible to draw a wide section of our personnel into the work of solving these big and complex problems, and to receive many valuable criticisms and suggestions.

The entire staff of our plant is eager unflaggingly to advance Soviet hydroturbine engineering so that our electric power production capacities should grow ahead of the development of the other branches of our national economy.

Visit the Hungarian Pavilion at the Indian Industries Fair in New Delhi

GANZ



manufacture **ELECTRIC MOTORS**
that are well-known all over the world.
Short times of delivery for outputs
upto 100 HP.

We can also supply high-voltage
and low-voltage switchgear for
short times of delivery.

Full information supplied by :

»TECHNOIMPEX«

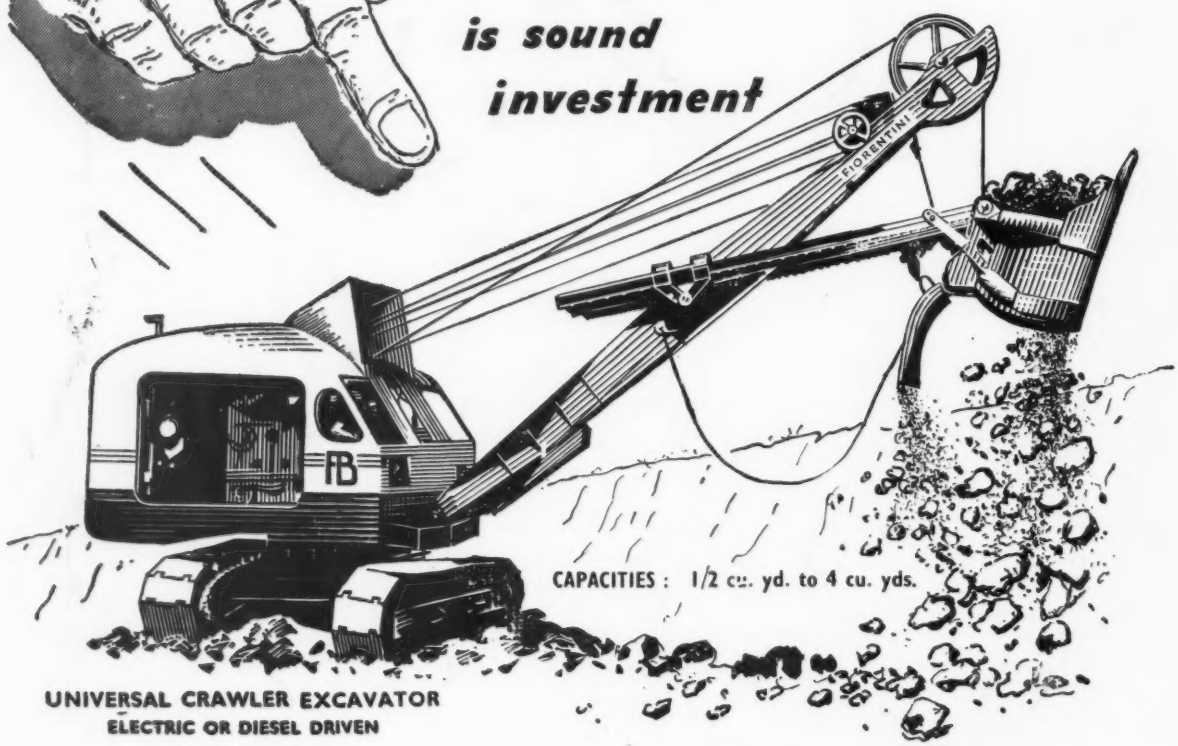
**HUNGARIAN MACHINE INDUSTRIES
FOREIGN TRADE COMPANY**

BUDAPEST 62. P.O.B. 183. HUNGARY.

Represented by : **KAYCEE & CO. LTD.
Kamani Chambers, Nicol Road,
Ballard Estate, Bombay 1.**

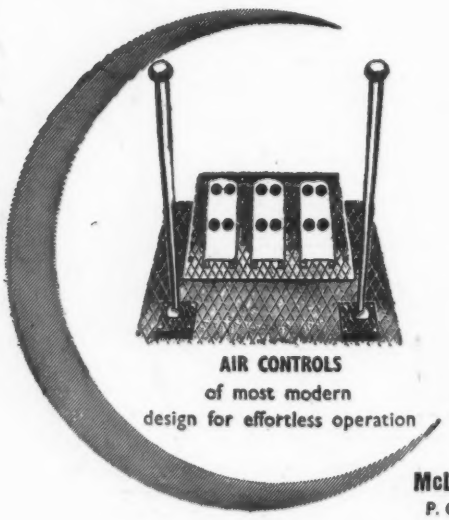
Printed and published by P. K. Menon from Inland Printing Works, 60-3 Dharamtala Street, Calcutta 13
Editorial & Managerial Office : 6, Waterloo Street, Calcutta 1

Here is sound investment



CAPACITIES : 1/2 cu. yd. to 4 cu. yds.

UNIVERSAL CRAWLER EXCAVATOR
ELECTRIC OR DIESEL DRIVEN



AIR CONTROLS
of most modern
design for effortless operation

Progress in industry depends on doing things better than they have been done before. Fiorentini Excavators illustrate the truth of this principle. Wherever Fiorentini Excavators have been employed—in sand and gravel pits, open-cast mines, on building works, roads and water undertakings—they have proved superior in operational speed, resulting in greater output in less time. This makes every Fiorentini Excavator a sound and profitable investment.

Attachments : Front Shovel • Dragline
Back Hoe • Clamshell • Crane • Pile-Driver

FIORENTINI

Distributors in India :

McLEOD & CO., LTD.
P. O. BOX 78, CALCUTTA.
TERRITORIES :
WEST BENGAL, BIHAR, ORISSA, UTTAR PRADESH, DELHI, MADRAS, ANDHRA, ASSAM, MANIPUR, TRIPURA, MYSORE, COORG, TRAVANCORE AND COCHIN STATES.

KILLICK, NIXON & CO. LTD.
P. O. BOX 109, BOMBAY.
TERRITORIES :
BOMBAY STATE, MADHYA PRADESH, HYDERABAD, RAJASTHAN, KASHMIR, PEPSU AND HIMACHAL PRADESH.

PSMF 1